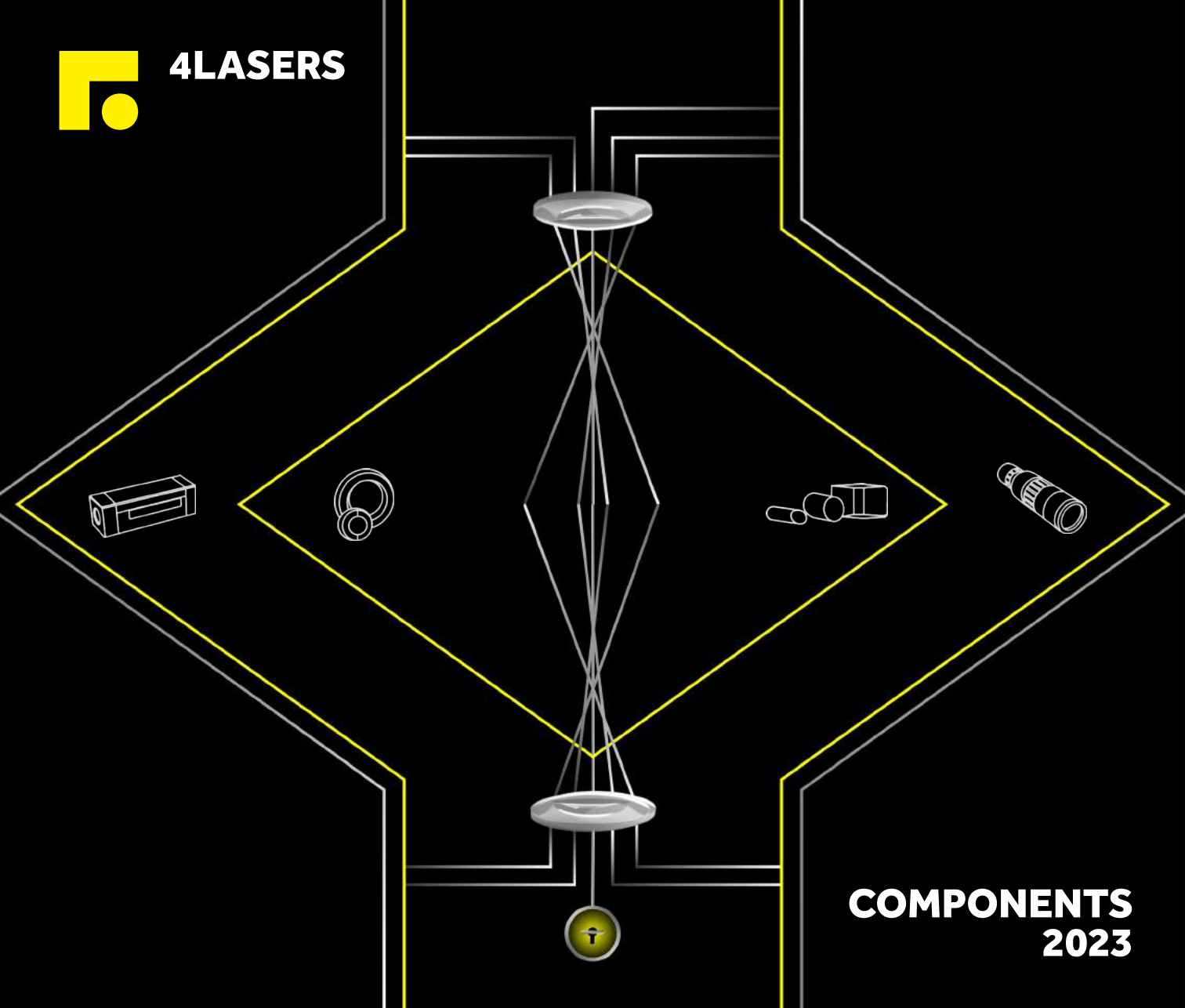
4LASERS



COMPONENTS 2023

4 LASERS

COMPONENTS
VOL. 5 | 2023

Content

About us

4Lasers is a division of Optogama company created in order to supply high-quality laser and nonlinear crystals, optical elements, beam delivery devices, accessories and laser setups.

4Lasers main capabilities and specialties

- Production of standard and custom laser optical components, laser, and nonlinear crystals
- Design and development of custom laser gain, optical modules, and beam delivery devices
- Development and production of different laser crystal hosts and ion dopant combinations
- Conventional and state of the art laser optics
- Refurbishment of optical elements, crystals
- Optical and optomechanical design of laser gain modules and optical devices

2022

NEW PREMISES

New office building. Wide space for company team expansion, new dedicated production facilities, ISO7 class metrology, assembling and R&D labs.

IMPLEMENTED ISO 9001 STANDARD

Bureau Veritas Certification Holding SAS – UK Branch certified the Management System of the Optogama in accordance with the ISO 9001:2015 requirements.

2021

2020

FAST COMPANY GROWTH

Financial Times announced Optogama as one of Europe's fastest-growing companies with an absolute growth rate - 250,2%.

NEW LASERS

Compact "eye-safe" 1,54 µm wavelength nanosecond lasers "KAUKAS" series and Nd:YAG passively q-switched DPSS laser WAVEGUARD were introduced to the market.

2019

2018

NEW COMPANY DIVISION

Opening of "4Lasers" - new company division for Laser Components supplying.

METROLOGY AND QUALITY ASSURANCE LAB

Newly set up laboratory improved quality management system that allows us to give relevant, reliable and timely test results.

2017

2016

FIRST R&D PROJECTS

1) Compact "eye-safe" 1,54 µm wavelength nanosecond lasers "KAUKAS" series.
2) ASGARD - a source for gas analysis and real time detection.

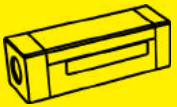
COMPANY ESTABLISHMENT

Young and ambitious team was created in order to design, develop and commercialize custom and unique laser products.

2015

Optical design and engineering

- Over 16 years of experience in the laser and photonics industry
- >70% of staff with a technical background in Laser Physics
- Strength in custom design and production of optical components, beam delivery devices
- Highly efficient communication and short lead time even for custom production
- Assurance of standardized production and quality according to ISO9001
- Guaranteed superior price-performance ratio

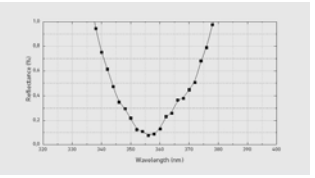


Services

4Lasers members are looking forward to cooperating with you, assisting in implementing your projects from ideas until full accomplishment.

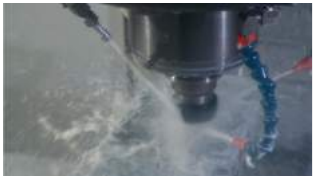
Optical design

Optics production

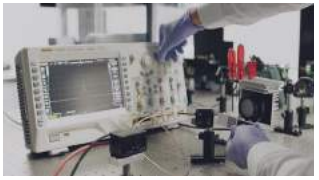


Coating services

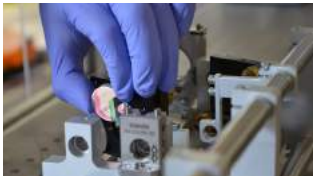
Optomechanical engineering



Mechanical workshop



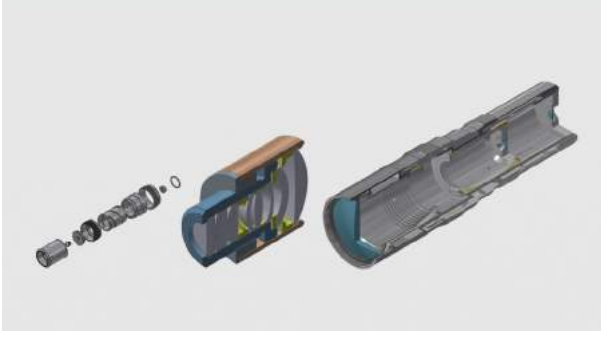
Metrology and quality assurance



Laser development

Crystal materials development and refurbishment

Optical design



From simple lenses to complex assemblies

The company offers low- and high-power, diffraction-limited optical solutions, which are customized to meet customers specific needs. While developing systems we also consider integrating customers' mechanical and software interfaces.

Available services, based on your requirements

- Optical design and production of optical elements
- Lens, objectives, beam expanders and collimation optical design
- Beam delivery and light pass modules design
- Laser gain modules and resonators optical design
- Verification and optimization services for your optical design
- Optical material, gain media, optical coatings modeling, design and selection

Features

- Perception of your application
- Integrated optomechanical system and sequential refractive design
- Gaussian beam propagation simulation according to given beam parameters
- Design and manufacturing technologies according to specified requirements
- Optics and coatings optimization for high damage threshold and high transmittance

Optics production

From raw materials to precise optical components

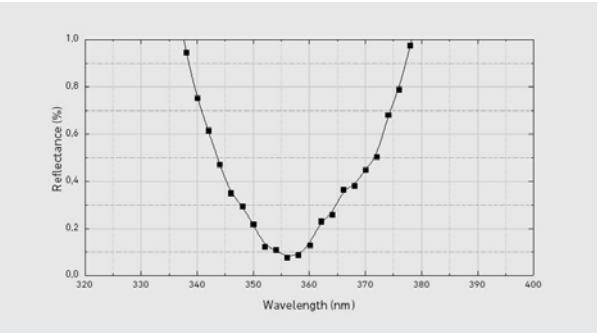
4lasers manufactures variety of precision optical components, crystals and optical assemblies.
Our dedicated and skilled team will ensure that you receive the optimal solution for your application.

Starting from raw materials of various glasses or laser crystals we offer

- Precision cutting and grinding
- Rounding and centration
- Double side and single side polishing
- Optical contacting and bonding
- Optical coatings

FEATURES AND CAPABILITIES	
Diameter and size	1 - 180mm
Cutting tolerance	±0,02mm
Diameter or size tolerance	Up to +0/-0,02mm
Thickness tolerance	Up to ±0,02mm
Surface flatness (P-V)	Up to λ/10
Irregularity (P-V)	Up to 0,1λ
Centering (Beam Deviation)	3 arcmin
Surface Quality	10-5 to 80-50 S-D

Coating services



Ensuring top quality of coatings, offering compliance testing

The company offers design and manufacturing of customized optical components for laser and vision applications with an optimum of coating performance and cost efficiency.

Available coating services based on these technologies:

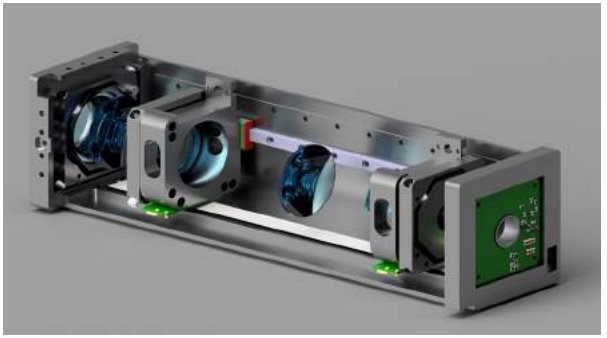
- Magnetron sputtering (MS)
- ion beam sputtering (IBS)
- ion assisted e-beam evaporation (E-beam IAD)
- Atomic layer deposition (ALD)

The variety of coating technologies enables a high-volume fabrication for series products as well as a flexible prototype manufacturing for R&D of:

- Anti-Reflection Coatings
- High Power Reflective Coatings
- Ultrafast Coatings
- Infrared Coatings
- Metallic Coatings
- Beamsplitters
- Dichroic Filters
- ITO Coatings

Optogama offer a wide variety of compliance testing to ensure the highest quality of precision optical thin film coating.
Testing capabilities include complete spectral measurement from 190nm to 12000nm, wavefront error, GDD, humidity & durability testing in multiple temperature cycles.

Optomechanical engineering



Top expertise in custom precision optomechanical engineering

Our highly skilled and experienced mechanical engineers provide complete mechanical and optomechanical design services whether you need a new product, or an update and improve existing design.

We're specializing in custom precision mechanical and optomechanical engineering in the photonics industry. By combining our competences in optical and mechanical design and integrating high-quality custom components, our team delivers custom design solutions and engineering services.

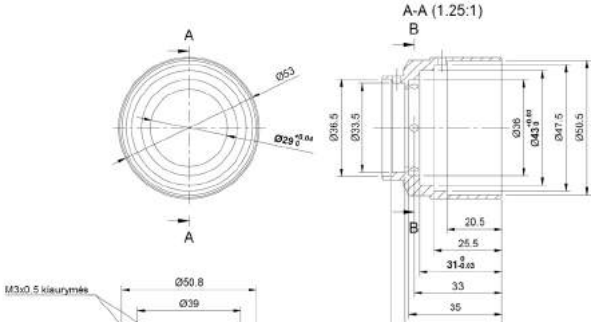
Main capabilities:

- Custom laser beam delivery and light path system engineering
- Optical systems engineering
- Optomechanical engineering and prototyping
- Designing with Solidworks and Zemax
- Optical, mechanical and electronics integration

Features:

- Development of concept
- Detailed analysis, prototyping and testing
- Using best practices for CAD and CAM

Mechanical workshop



Design and production of precision optomechanical parts

We offer experience in producing of precision optomechanical parts and components for laser and optical systems, biotechnology, medicine and other industries.

Starting from design using "Solidworks" and using "CAMWorks" for CAM programming. we design and produce our own fixtures for part manufacturing.

Manufacturing capabilities:

CNC turning: DMG MORI CLX 450 High-end universal turning machine with direct measuring system.

- Max. workpiece diameter — 400 mm, max. workpiece length — 800 mm.
- The machine has a Y axis, active tools and two spindles.
- Efficient manufacturing of parts, especially series production, due to a bar feeder.

CNMC Milling: HAAS VF2-SS and DMG DMU 50

- Max dimensions on X axis — 762 mm, on Y axis — 450 mm; on Z axis — 500 mm; Workpiece dimensions depend on the finished part's shape, material, and elements which it contains.
- Rotations on C axis +/-360°, on B axis — +110°/-5°.
- 5 axis and 3+2 milling provides the ability to efficiently process parts of different and unique configurations

In addition to metal processing we offer Anodizing, Sand blasting, Glass blasting, Tumbling, Engraving, vacuum cleaning and other services

Features

- From single piece to serial production
- Prompt delivery from 1 week
- Quality control services (CMM HEXAGON Global Lite)
- Consultations and product design optimisation

Metrology and quality assurance

Standard and non-standard measurements

The state-of-the-art devices and tools are used to test optical elements, which are integrated into lasers and laser-related systems.

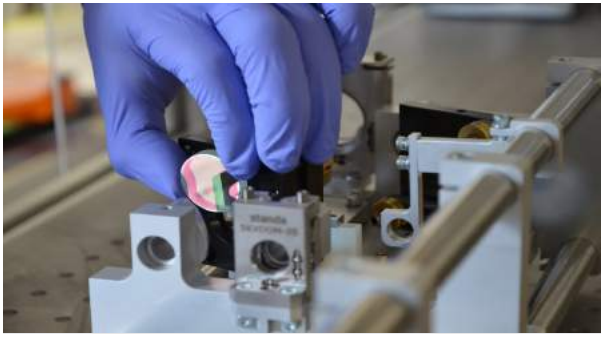
Standard metrology services

- Wavefront distortion in transmittance/reflectance for parallel and spherical optics (Verifire, Zygo)
- Transmittance and reflectance of optical elements in 200-1700 nm wavelength range (Photon RT, EssentOptics)
- Optical microscopy with polarized light option (Olympus)
- Beam quality (BeamSquared, Ophir)
- Wavelength stability for lasers with 3 pm resolution (WS6, HighFinesse)
- Environmental temperature & humidity tests to test laser performance, coating durability, glue aging, etc. (Binder, Espec)
- Shock and vibration tests

Non-standard test measurements

In case you did not find test measurement that suits your needs, please contact us for non-standard services.

Laser development



Experts in custom designed laser solutions

Our team has an expertise to develop, design, test and produce custom designed laser solutions to meet your unique requirements and stringent OEM applications. It is also available to modify or upgrade standard commercial and scientific lasers.

Our knowledge is based on diode laser-pumped solid-state laser design and assembling, based on passive Q-switching.
Experience working with Er,Yb:glass, Pr:YLF, Nd:YAG, Er:YAG, Nd:YVO, Ti:Sapphire and other laser materials allows us to design and test your laser prototypes within short time.

Available solutions:

- From simple modifications to the design of specific and innovative prototype
- Customer visits to assess the requested project and consultations with teams from R&D, including mechanical and optical design groups
- Customization and special engineering services

Features:

- From optical design to prototype validation
- investigations of various laser gain media and passive q-swithing crystal based models
- Side and end LD pumping
- Prototyping and environmental testing

Laser crystals material development and refurbishment

Crystals growth, laser gain media development, crystals refurbishment

We are experts in crystal growth also capable of design and development of custom laser gain and optical modules, state-of-the-art monolithic crystal assemblies and damaged crystals refurbishment service. Our expertise comes from cooperation with scientific and industrial partners through numerous R&D contracts. For damaged crystals we provide cost-effective crystal refurbishment service, including repolishing, recoating, and characterization.

Capabilities:

- Ultrafast laser gain media (Yb:KGW, Yb:KYW, Ti:Sapphire, CaF2, Pr:YLF, Tm:YLF, Ho:YLF, Er:YLF)
- Passive Q-switch elements (crystalline or ceramic Co:Spinel, Cr:YAG, V:YAG)
- Photorefractive crystals (BSO and BGO, SBN)

Available crystal growth techniques:

- Stepanov
- Modified Flux growth
- Kyropoulos
- Czochralski

Features:

- Custom gain and doping levels
- Material characterization and processing
- Production of final elements

Repolishing of laser, nonlinear and photorefractive crystals	
Size	Up to 50mm
Surface quality	Up to 10-5 S-D
Surface flatness	Up to λ/10@632,8 nm (for 6x6 mm and smaller crystals)
Coatings	Upon request

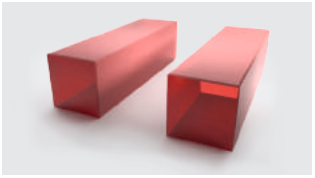
Features:

- Fast delivery from 1 week
- Repolishing & resizing
- Recoating
- Metrology and quality assurance

Crystals

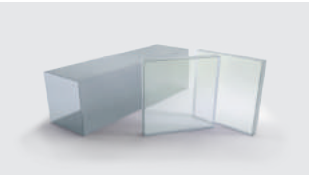
Whether you are setting up your laser experiment or integrating a commercial product, we have competitively high-performance crystals for your needs.

Do not hesitate to request custom, if the crystal is not in the standard crystals section.

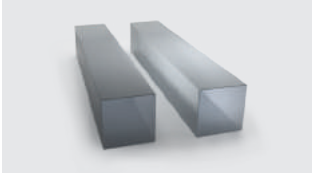


Laser crystals

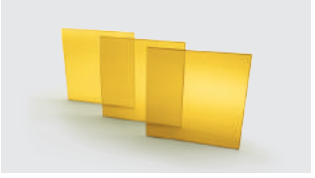
Passive Q-switch crystals



Nonlinear crystals



Raman crystals

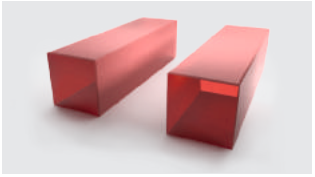


Photorefractive crystals

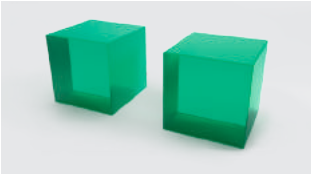
Laser crystals

Laser crystals, glasses and ceramics are used as optical gain sources in solid-state lasers. These media are typically doped with rare-earth ions (e.g. neodymium, ytterbium, or erbium) or transition metal ions (titanium or chromium).

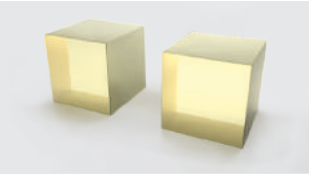
4Lasers develops and supplies different laser crystal hosts and ion dopant combinations for fundamental, applied research and industrial applications. Available crystal growth techniques: Stepanov, Modified Flux growth, Kyropoulos and Czochralski.



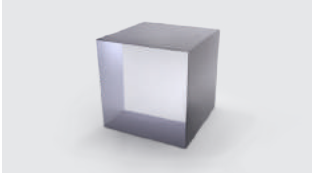
Ti:Sapphire crystals



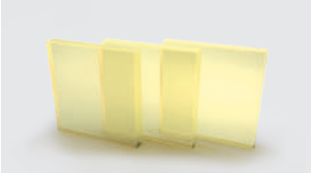
Cr:LiSAF crystals



Pr:YLF crystals

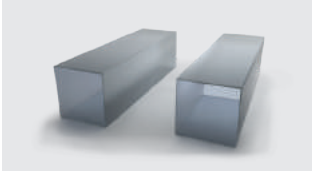


Ho:YLF crystals

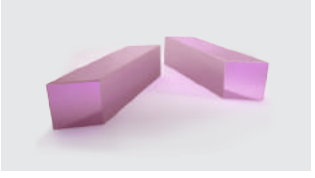


Tm, Ho:KYW crystals

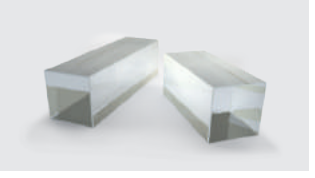
Nd-doped crystals



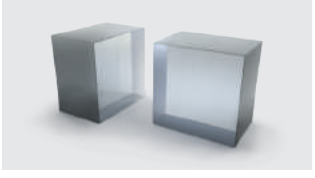
Yb-doped crystals



Er-doped crystals

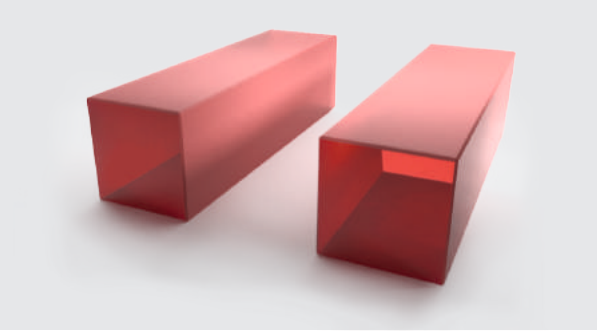


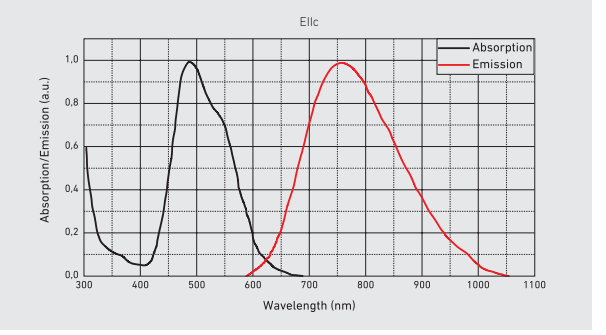
Er, Yb co-doped crystals



Tm-doped crystals

Ti:Sapphire crystals





Titanium-doped sapphire ($Ti^{3+}:Al_2O_3$) is a widely used transition-metal-doped laser crystal. Ti^{3+} ion has a very large gain bandwidth, that opens possibility to obtain very wide wavelength tunability realized in short pulse lasers. To obtain crystals with good optical quality Ti^{3+} doping concentration should not exceed 0,25 at.%. Ti:Sapphire crystal is characterized by a short upper-state lifetime and a high saturation power. All these properties lead to the necessity of using a strongly focused pump beam.

Main features

- Excellent thermal conductivity
- Broad gain bandwidth
- Wide range of possible pump wavelengths (typically 532 nm)
- Custom crystals available upon request

Application examples

- Mode-locked lasers with ultrashort pulses
- Multi-pass amplifiers and regenerative amplifiers

Standard specifications

TI:SAPPHIRE CRYSTALS	
Orientation	a-cut
Absorption	90-95% of 532 nm pump radiation
Figure of merit	>150 (for 15 mm and longer crystals)
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<30 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm (for 6x6 mm and smaller crystals)
Wavefront distortion	λ/4@632,8 nm
Coatings	AR(R<1%)@532 nm + AR(R<0,3%)@750-850 nm on both faces
LIDT	>2 J/cm²@800 nm, 300 ps
Mount	Unmounted

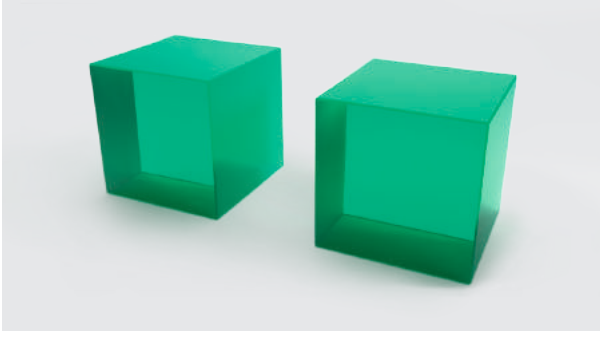
Properties

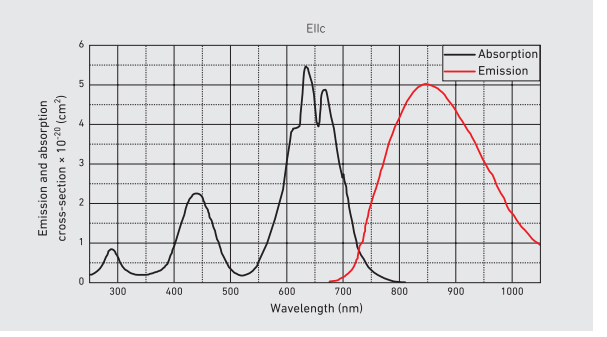
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	~500 nm
Absorption cross-section at peak wavelength	38×10^{-20} cm^2
Laser wavelength	790 (670-1070) nm
Lifetime of energy level	3,2 µs
Emission cross-section @790 nm	41×10^{-20} cm^2
Refractive index @800 nm	1,76
Crystal structure	hexagonal
Density	3,98 g/cm^3
Mohs hardness	9
Thermal conductivity	33 Wm^{-1} K^{-1}
dn/dT	13×10^{-6} K^{-1}
Thermal expansion coefficient	5×10^{-6} K^{-1}
Typical doping level	0,1-0,25 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	COATINGS	SKU	PRICE
3 x 3 mm	5 mm	Brewster-angle cut	Uncoated	6633	880 €
3 x 3 mm	5 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6632	980 €
6 x 6 mm	7 mm	Brewster-angle cut	Uncoated	6635	980 €
6 x 6 mm	7 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6634	1080 €
6 x 6 mm	10 mm	Brewster-angle cut	Uncoated	6637	980 €
6 x 6 mm	10 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6636	1080 €
6 x 6 mm	15 mm	Brewster-angle cut	Uncoated	6639	1080 €
6 x 6 mm	15 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6638	1180 €
ø6 mm	20 mm	Brewster-angle cut	Uncoated	6641	1080 €
ø6 mm	20 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6648	1180 €
ø12 mm	15 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6640	2150 €
ø16 mm	20 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6642	3950 €
ø20 mm	25 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6643	4950 €
ø30 mm	25 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6644	Request
ø40 mm	25 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6645	Request
ø50 mm	25 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6646	Request
50 x 50 mm	30 mm	Right-angle cut	AR/AR@532 nm + 750-850 nm	6647	Request

Cr:LiSAF crystals





Cr^{3+}:LiSAF gain medium possesses a broad emission band in the near infrared that allows a widely tunable laser operation and generation of ~10 fs light pulses via mode-locking technique. Cr:LiSAF crystals can be grown with a very low loss level (<0,2%/cm). It enables to construct high-Q-cavities, resulting in lasing thresholds as low as 2 mW and slope efficiencies above 50%. Moreover, nonlinear refractive index of Cr:LiSAF is about four times lower than that of Ti:sapphire, which reduces parasitic nonlinearities in the ultrashort pulse generation and amplification applications.

Main features

- Broad absorption and emission bands
- Nonlinear refractive index is about four times lower than that of Ti:Sapphire
- Custom crystals available upon request

Application examples

- Femtosecond lasers and CPA laser systems

Standard specifications

CR:LISAF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<1%)@670 nm + AR(R<0,5%)@700-1100 nm on both faces
Laser induced damage threshold	>10 J/cm²@1064 nm, 10 ns
Mount	Unmounted

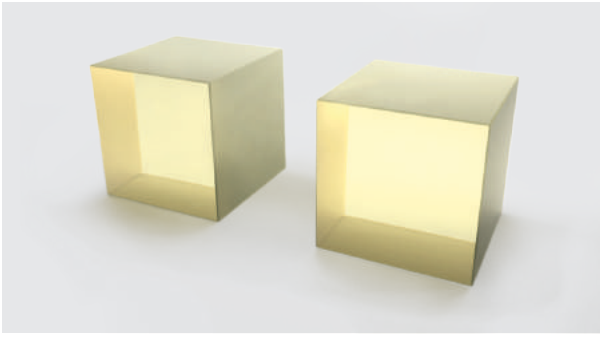
Properties

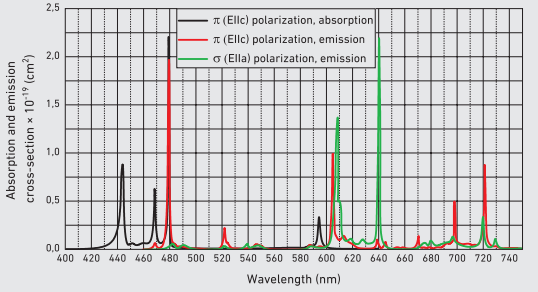
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	670 nm
Absorption cross-section at peak	$5{,}5 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	~100 nm
Laser wavelength	830 (780-920) nm
Lifetime of $^4T_2$ energy level	67 µs
Emission cross-section	5×10^{-20} cm^2
Refractive index	1,41
Crystal structure	trigonal
Density	3,45 kg/cm^3
Mohs hardness	4
Thermal conductivity	4,6(||a), 5,1 (||c) Wm^{-1}K^{-1}
dn/dT	$-4{,}2 \times 10^{-6}$ K^{-1} (n_o), $-4{,}6 \times 10^{-6}$ K^{-1} (n_e)
Thermal expansion coefficient	22×10^{-6}(||a) K^{-1}, $3{,}6 \times 10^{-6}$(||c) K^{-1}
Typical doping level	0,8-3 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
5 x 5 mm	12 mm	Brewster-angle cut	3%	Uncoated	7820	770 €
		Right-angle cut	3%	AR/AR@670 nm + 700-1100 nm	7819	930 €

Pr:YLF crystals





Very few laser materials have necessary properties for realization of lasing in the visible spectral range. Trivalent praseodymium (Pr^{3+}) is known to be an interesting laser ion for using with solid-state lasers in the visible spectral range because of its energy levels scheme, providing several transitions in the red (640 nm, $^3P_0$ to $^3F_2$), orange (607 nm, $^3P_0$ to $^3H_6$), green (523 nm, $^3P_0$ to $^3H_5$), and dark red (720 nm, $^3P_0$ $^3F_3$+$^3F_4$) spectral regions. Pr^{3+}:YLF has been found to be a promising laser material for producing visible lasers directly and UV lasers through intracavity second-harmonic generation.

Main features

- High absorption and emission cross-sections(~10^{-19} cm^2)
- Good overlapping of the absorption band in the blue spectral region with the emission lines of the InGaN laser diodes and 2ω-OPSL
- Custom crystals available upon request

Application examples

- Diode-pumped solid-state lasers for precise and efficient processing of metals such as copper or gold, entertainment industry and science

Standard specifications

PR:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	λ/4@632,8 nm
Coatings	AR(R<1%)@440-444 nm + AR(R<0,6%)@500-650 nm + AR(R<1%)@650-725 nm on both faces
Laser induced damage threshold	>5 J/cm²@532 nm, 10 ns
Mount	Unmounted

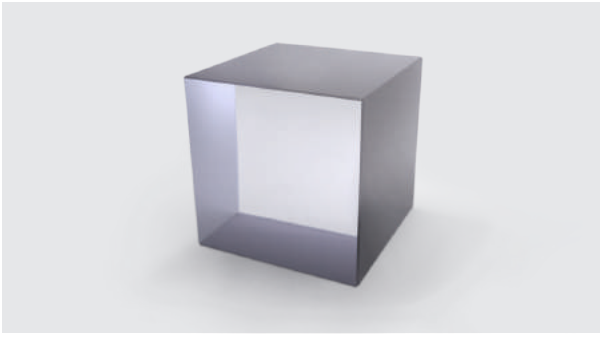
Properties

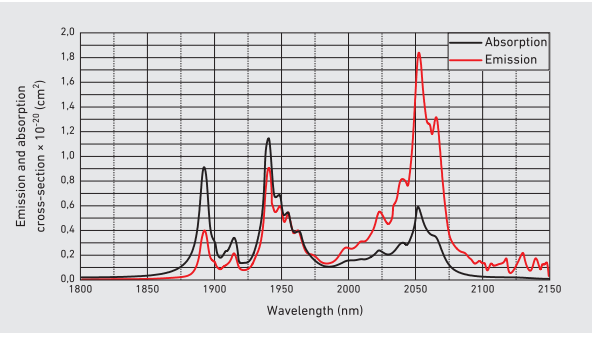
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	444 nm
Absorption cross-section at peak	8×10^{-20} cm^2
Absorption bandwidth at peak wavelength	~5 nm
Laser wavelength	523 nm, 607 nm, 639 nm, 698 nm, 721 nm
Lifetime of $^3P_0$ energy level	50 µs
Emission cross-section at 640 nm	20×10^{-20} cm^2
Refractive index @1064 nm	n_o = 1,448, n_e = 1,470
Crystal structure	tetragonal
Density	3,95 g/cm^3
Mohs hardness	5
Thermal conductivity	6 Wm^{-1}K^{-1}
dn/dT	$-5{,}2 \times 10^{-6}$ (||c) K^{-1}, $-7{,}6 \times 10^{-6}$ (||a) K^{-1}
Thermal expansion coefficient	~16 × 10^{-6} K^{-1}
Typical doping level	<1 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
2 x 2 mm	6 mm	Right-angle cut	0,5%	AR/AR@440-444 nm + 500-725 nm	7793	480 €
3 x 3 mm	6 mm	Right-angle cut	0,5%	AR/AR@440-444 nm + 500-725 nm	7794	540 €
ø5 mm	6 mm	Right-angle cut	0,5%	AR/AR@440-444 nm + 500-725 nm	7795	640 €

Ho:YLF crystals





Direct pumping of Ho:YLF crystals excludes losses of Tm^{3+} to Ho^{3+} energy transfer process. Ho^{3+}:YLF crystal is characterized by a long lifetime of $^5I_7$ energy level which results in an excellent performance in Q-switched operation.

Main features

- Long upper laser level lifetime
- High emission cross-section
- Naturally birefringent material
- Low value of dn/dT leading to a weak thermal lensing
- Custom crystals available upon request

Application examples

- Remote sensing and pollutant detection
- Industry
- Military

Standard specifications

HO:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,35%)@1900-2100 nm on both faces
LIDT	>10 J/cm²@2060 nm, 10 ns
Mount	Unmounted

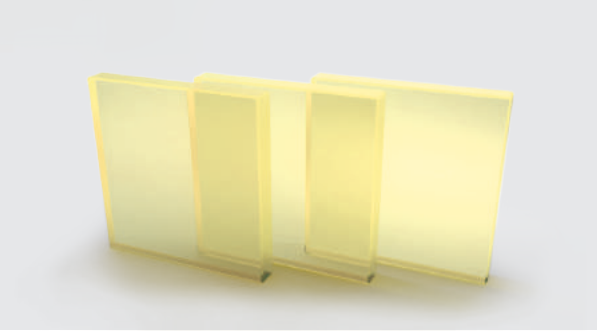
Properties

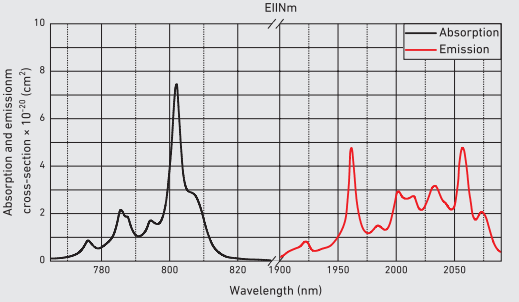
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	1940 nm
Absorption cross-section at peak	$1,2 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	~18 nm
Laser wavelength	2060 nm
Lifetime of $^5I_7$ energy level	10 ms
Emission cross-section	$1,8 \times 10^{-20}$ cm^2
Refractive index @1064 nm	$n_o = 1,448$, $n_e = 1,470$
Crystal structure	tetragonal
Density	3,95 g/cm^3
Mohs hardness	5
Thermal conductivity	6 $Wm^{-1}K^{-1}$
dn/dT	$-4,6 \times 10^{-6}$ (||c) K^{-1}, $-6,6 \times 10^{-6}$ (||a) K^{-1}
Thermal expansion coefficient	$10,1 \times 10^{-6}$ (||c) K^{-1}, $14,3 \times 10^{-6}$ (||a) K^{-1}
Typical doping level	0,5-1%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
5 x 5 mm	2 mm	Brewster-angle cut	1%	Uncoated	7857	580 €
	2 mm	Right-angle cut	1%	AR/AR@1900-2100 nm	7858	700 €
ø8 mm	2 mm	Brewster-angle cut	1%	Uncoated	7859	580 €
	2 mm	Right-angle cut	1%	AR/AR@1900-2100 nm	7860	700 €

Tm, Ho:KYW crystals





Ho^{3+} ions are characterized by higher emission cross-sections and longer upper laser level lifetimes compared to their Tm^{3+} counterparts. These features are desirable for a low-threshold and efficient laser operation. Ho^{3+} does not possess any strong absorption lines that are well matched to the outputs of commercially available laser diodes, therefore co-doping of Ho^{3+} with Tm^{3+} is chosen for an efficient operation across the 2 µm region through the energy transfer route from Tm^{3+} to Ho^{3+}. Tm, Ho:KYW crystals are characterized by large and broad polarized absorption and emission bands, efficient energy transfer from Tm^{3+} to Ho^{3+}.

Main features

- Large and broad polarized absorption and emission bands
- Efficient energy transfer from Tm^{3+} to Ho^{3+}
- High dopant concentration with low concentration-quenching
- Custom crystals available upon request

Application examples

- 2 µm lasers for remote sensing (LIDAR technology), metrology and medical applications
- Pump source of mid-IR optical parametric oscillators (OPOs)

Standard specifications

TM, HO:KYW CRYSTALS	
Orientation	N_g-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@802 nm + AR(R<0,2%)@2000-2100 on both faces
LIDT	>10 J/cm²@2060 nm, 10 ns
Mount	Unmounted

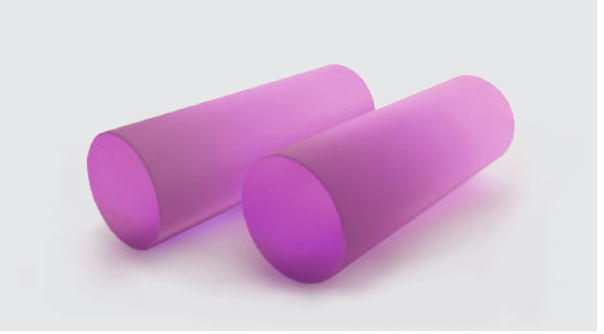
Properties

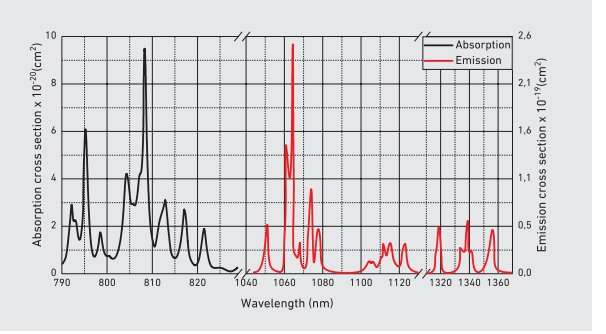
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	802 nm
Absorption cross-section at peak	$7{,}6 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	~4 nm
Laser wavelength	2060 nm
Lifetime of $^5I_7$ energy level	1,8 ms
Emission cross-section @2056 nm	$4{,}7 \times 10^{-20}$ cm^2
Refractive index @1040nm	$n_g = 2{,}05$, $n_m = 2{,}01$, $n_p = 1{,}97$
Crystal structure	monoclinic
Density	6,5 g/cm^3
Mohs hardness	4-5
Thermal conductivity	~3,3 Wm^{-1}K^{-1}
dn/dT	$dn_m/dT = -9{,}2 \times 10^{-6}$ K^{-1}
Thermal expansion coefficient	$\alpha_p = 1{,}83 \times 10^{-6}$ K^{-1}, $\alpha_m = 10{,}29 \times 10^{-6}$ K^{-1}, $\alpha_g = 15{,}94 \times 10^{-6}$ K^{-1}
Typical doping level	5 at.% [Tm] 0,5 at.% [Ho]

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	2 mm	Brewster-angle cut	Tm 5%, Ho 0,5%	Uncoated	7856	Request
		Right-angle cut	Tm 5%, Ho 0,5%	AR/AR@802 nm + 2000-2100 nm	7855	Request

Nd:YAG crystals





Nd^{3+}:YAG crystal is the most widely used solid-state laser material. These crystals are characterized by relatively small gain bandwidth, which allows achieving a high gain efficiency and a relatively low lasing threshold.

Nd:YAG crystals feature excellent thermal and mechanical properties. Nd:YAG of high optical quality and large diameter can be grown.

Main features

- Isotropic crystal (cubic symmetry)
- High thermal conductivity
- High optical quality and large diameter boules grown by Czochralski growth method
- Low lasing threshold and wide absorption band at near 808 nm that coincides with the emission of AlGaAs laser diodes
- Custom crystals available upon request

Application examples

- CW and pulsed operation at 1064 nm, 532 nm, 355 nm, 266 nm
- Material processing, welding, cutting
- Laser systems for medical applications

Standard specifications

ND:YAG CRYSTALS	
Orientation	[111]
Extinction ratio	>28 dB
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	λ/4@632,8 nm
Coatings	AR(R<0,15%)@1064 nm on both sides or HT(T>95%)@808 nm + HR(R>99,5%)@1064 nm/ AR(R<0,15%)@1064 nm
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns
Mount	Unmounted

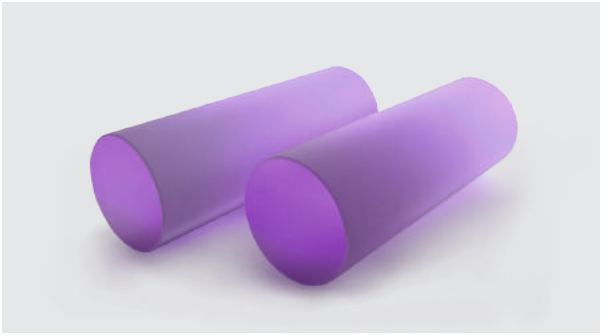
Properties

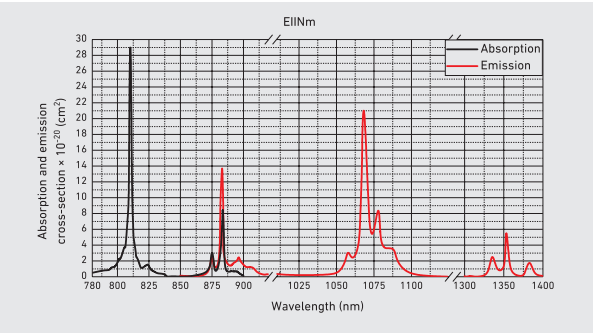
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	808 nm
Absorption cross-section at peak	$6{,}7 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	2,5 nm
Laser wavelength	1064 nm
Lifetime of $^4F_{3/2}$ neodymium energy level	250 µs
Emission cross-section @1064	3×10^{-19} cm^2
Refractive index @1064 nm	1,82
Crystal structure	cubic
Density	4,56 g/cm^3
Mohs hardness	8,5
Thermal conductivity	~13 Wm^{-1}K^{-1}
dn/dT	$9{,}86 \times 10^{-6}$ K^{-1}
Thermal expansion coefficient	$6{,}96 \times 10^{-6}$ K^{-1}
Typical doping level	0,6 - 1,3 at. %

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
ø3 mm	10 mm	Right-angle cut	0,8%	AR/AR@1064 nm	7106	260 €
	50 mm	Right-angle cut	0,8%	AR/AR@1064 nm	7071	360 €
	100 mm	Right-angle cut	0,8%	AR/AR@1064 nm	7072	490 €
ø5 mm	10 mm	Right-angle cut	0,8%	AR/AR@1064 nm	7076	280 €
	50 mm	Right-angle cut	0,8%	AR/AR@1064 nm	7077	390 €
	100 mm	Right-angle cut	0,8%	AR/AR@1064 nm	7078	590 €
ø3 mm	10 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7073	260 €
	50 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7074	360 €
	100 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7075	490 €
ø5 mm	10 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7079	280 €
	50 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7080	390 €
	100 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7081	590 €
3 x 3 mm	2 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7082	220 €
	2 mm	Right-angle cut	1,1%	HT@808 nm + HR@1064 nm/AR@1064 nm	7085	240 €
	3 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7083	220 €
	3 mm	Right-angle cut	1,1%	HT@808 nm + HR@1064 nm/AR@1064 nm	7086	240 €
	5 mm	Right-angle cut	1,1%	AR/AR@1064 nm	7084	220 €
	5 mm	Right-angle cut	1,1%	HT@808 nm + HR@1064 nm/AR@1064 nm	7087	240 €

Nd:KGW crystals





Nd:KGW crystal is a good choice for generation of picosecond laser pulses. These crystals are characterized by a lower stimulated emission cross-section compared to Nd:YAG crystals, therefore provide a better performance in Q-switched operation. It is worth to mention, that it is possible to use the Nd:KGW laser crystal itself as a Raman converter.

Main features

- Suitable for generation of picosecond light pulses, well suited for diode-pumped lasers
- High storage density and low laser threshold
- Efficient Raman converter
- Custom crystals available upon request

Application examples

- Diode-pumped Q-switched lasers emitting in the “eye-safe” spectral range for laser rangefinders
- Raman converter

Standard specifications

ND:KGW CRYSTALS	
Orientation	b(N_p)-cut,
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)808-811 nm + AR(R<0,15%)@1067 nm on both faces
Laser induced damage threshold	>10 J/cm²@1067 nm, 10 ns
Mount	Unmounted

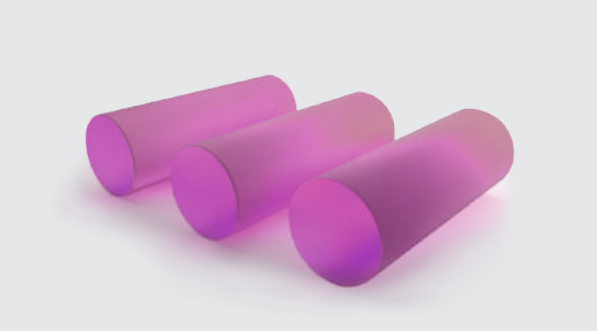
Properties

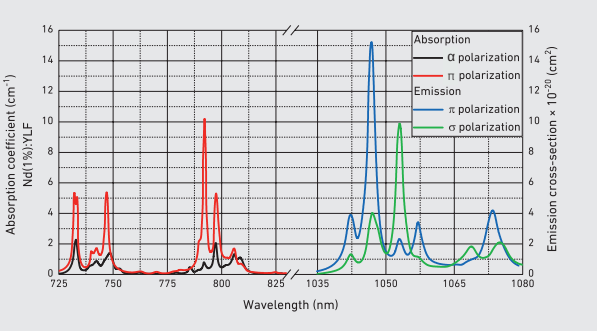
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	811 nm
Absorption cross-section at peak	28×10^{-20} cm^2
Absorption bandwidth at peak wavelength	11 nm
Laser wavelength	1067 nm
Lifetime of $^4F_{3/2}$ neodymium energy level	130 µs
Emission cross-section @1067 nm	21×10^{-20} cm^2
Refractive index @1067nm	n_g = 2,033, n_p = 1,937, n_m = 1,986
Crystal structure	Monoclinic
Density	7,25 g/cm^3
Mohs hardness	4-5
Thermal conductivity	~3 Wm^{-1}K^{-1}
dn/dT	$dn_p/dT = -15{,}7\times10^{-6}$ K^{-1} $dn_m/dT = -11{,}8\times10^{-6}$ K^{-1} $dn_g/dT = -17{,}3\times10^{-6}$ K^{-1}
Thermal expansion coefficient	$\alpha_p = 1{,}60 \times 10^{-6}$ K^{-1}, $\alpha_m = 4 \times 10^{-6}$ K^{-1}, $\alpha_g = 8{,}5 \times 10^{-6}$ K^{-1}
Typical doping level	2-10 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	5 mm	Right-angle cut	3%	AR/AR@808-811 nm + 1067 nm	7798	480 €
ø3 mm	60 mm	Right-angle cut	3%	AR/AR@1067 nm	7800	Request
3 x 3 mm	3 mm	Right-angle cut	5%	AR/AR@808-811 nm + 1067 nm	7796	480 €
3 x 3 mm	5 mm	Right-angle cut	5%	AR/AR@808-811 nm + 1067 nm	7797	480 €
ø3 mm	5 mm	Brewster-angle cut	5%	Uncoated	7799	420 €

Nd:YLF crystals





Nd^{3+}:YLF crystal is characterized by a long lifetime of $^4F_{3/2}$ neodymium energy level. Compared to Nd:YAG, the lower thermal conductivity and a weak negative dn/dT lead to lower thermal distortions and allow to achieve a better output beam quality. Another distinctive feature is the high UV transparency, which is favorable for pumping with xenon flashlamps.

Main features

- Long lifetime of $^4F_{3/2}$ neodymium energy level
- Considerably softer and more brittle than Nd:YAG is
- Nd:YLF (a-cut) crystals that are used inside a laser optical resonator are self-polarizing
- Custom crystals available upon request

Application examples

- CW and pulsed operation at 1047nm and 1053 nm
- Material processing, welding, cutting

Standard specifications

ND:YLF CRYSTALS	
Orientation	a-cut, c-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	λ/4@632,8 nm
Coatings	AR(R<0,5%)@790-810 nm + AR(R<0,2%) @1047-1053 nm on both faces
Laser induced damage threshold	>10 J/cm²@1064 nm, 10 ns
Mount	Unmounted

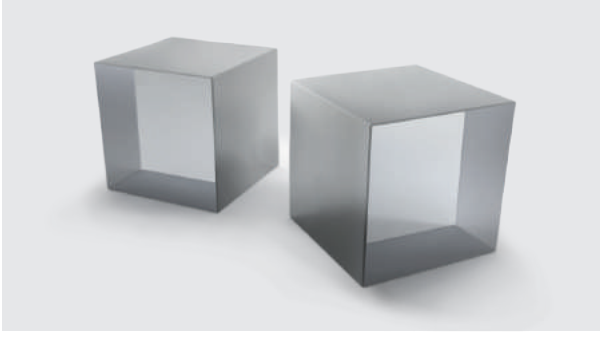
Properties

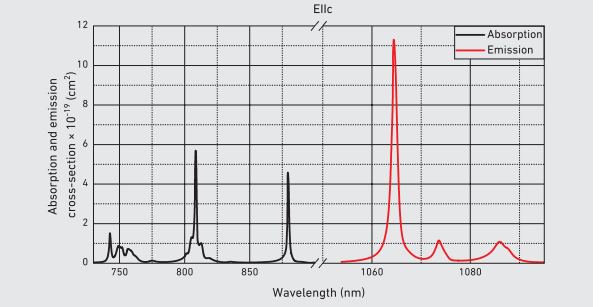
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	792 nm
Absorption coefficient at peak	10 cm^{-1}
Absorption bandwidth at peak wavelength	~5 nm
Laser wavelength	1047, 1053 nm
Lifetime of $^4F_{3/2}$ neodymium energy level	485 µs
Emission cross-section	15 × 10^{-20} (E||C) cm^2@1047 nm 10 × 10^{-20} (E⊥C) cm^2@1053 nm
Refractive index @1064 nm	n_o = 1,448, n_e = 1,470
Crystal structure	tetragonal
Density	3,95 g/cm^3
Mohs hardness	5
Thermal conductivity	6 $Wm^{-1}K^{-1}$
dn/dT	-4,6 × 10^{-6} (||c) K^{-1}, -6,6 × 10^{-6} (||a) K^{-1}
Thermal expansion coefficient	8 × 10^{-6} (||c) K^{-1}, 13 × 10^{-6} (||a) K^{-1}
Typical doping level	1-2 at. %

Standard products

FACE DIMENSIONS	LENGTH	END FACES	ORIENTATION	DOPING	COATINGS	SKU	PRICE
ø5 mm	10 mm	Right-angle cut	a-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7097	540 €
	20 mm	Right-angle cut	a-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7098	640 €
	50 mm	Right-angle cut	a-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7099	Request
	100 mm	Right-angle cut	a-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7100	Request
	10 mm	Right-angle cut	c-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7101	580 €
	20 mm	Right-angle cut	c-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7102	680 €
	50 mm	Right-angle cut	c-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7103	Request
	100 mm	Right-angle cut	c-cut	1%	AR/AR@790-810 nm + 1047-1053 nm	7104	Request

Nd:YVO_4 crystals





Compared to Nd^{3+}:YAG crystals, the Nd^{3+}:YVO_4 crystal has much higher absorption and emission cross-sections, a broader gain bandwidth and wavelength range for pumping, a shorter upper-state lifetime, a higher refractive index, thus it is characterized by a lower thermal conductivity. Nd:YVO_4 crystals are well suited for passively mode-locked lasers with high pulse repetition rates. A drawback of Nd:YVO_4 lasers is that it is impossible to achieve pulse energies as high as it is achievable with Nd:YAG lasers at Q-switched operation, due to the lower upper-state lifetime and higher gain efficiency. In conclusion, Nd:YVO_4 is better suited as an active medium of high pulse repetition rate Q-switched lasers and CW lasers with a lower lasing threshold.

Main features

- High absorption and gain cross-sections
- Strongly polarization dependent absorption and emission spectra (π-polarization is preferable)
- Shorter (compared with Nd:YAG) upper-state lifetime
- High optical quality and large diameter boules obtained by Czochralski growth method
- Custom crystals available upon request

Application examples

- High repetition rate Q-switched lasers for marking and engraving
- Mode-locked lasers for spectroscopy and research

Standard specifications

ND:YVO_4 CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Coatings	AR(R<0,5%)@808 nm + AR(R<0,15%)@1064 nm and HT(T>95%)@ + HR(R>99,8%)@1064 nm/ AR(R<0,2%)@1064 nm
Laser induced damage threshold	>10 J/cm^2@1064nm, 10 ns
Mount	Unmounted

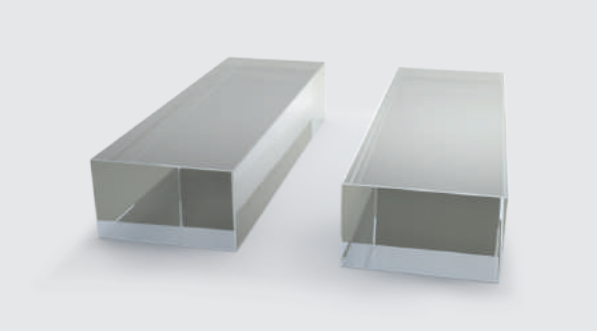
Properties

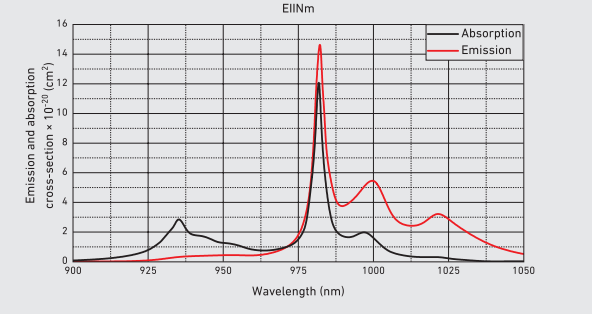
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	808 nm
Absorption cross-section at peak	$5{,}8 \times 10^{-19}$ cm^2
Absorption bandwidth at peak wavelength	16 nm
Laser wavelength	1064 nm
Lifetime of $^4F_{3/2}$ neodymium energy level	90 µs
Emission cross-section @1064 nm	$11{,}4 \times 10^{-19}$ cm^2
Refractive index @1064 nm	$n_o = 1{,}96$, $n_e = 2{,}17$
Crystal structure	Tetragonal
Density	4,22 g/cm^3
Mohs hardness	5
Thermal conductivity	~5 Wm^{-1}K^{-1}
dn/dT	$3{,}0 \times 10^{-6}$ (||c) K^{-1}, $8{,}5 \times 10^{-6}$ (||a) K^{-1}
Thermal expansion coefficient	11×10^{-6} (||c) K^{-1}, $4{,}4 \times 10^{-6}$ (||a) K^{-1}
Typical doping level	0,1-4 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	5 mm	Right-angle cut	1%	AR/AR@808 nm + 1064 nm	7105	280 €
		Right-angle cut	1%	HT@808 nm + HR@1064 nm/AR@1064 nm	7092	350 €
	2 mm	Right-angle cut	2%	AR/AR@808 nm + 1064 nm	7089	280 €
		Right-angle cut	2%	HT@808 nm + HR@1064 nm/AR@1064 nm	7094	350 €
	3 mm	Right-angle cut	2%	AR/AR@808 nm + 1064 nm	7088	280 €
		Right-angle cut	2%	HT@808 nm + HR@1064 nm/AR@1064 nm	7093	350 €
	0,5 mm	Right-angle cut	3%	AR/AR@808 nm + 1064 nm	7091	280 €
		Right-angle cut	3%	HT@808 nm + HR@1064 nm/AR@1064 nm	7096	350 €
	1 mm	Right-angle cut	3%	AR/AR@808 nm + 1064 nm	7090	280 €
		Right-angle cut	3%	HT@808 nm + HR@1064 nm/AR@1064 nm	7095	350 €

Yb:KGW crystals





Yb^{3+}:KGW crystals possess a large gain bandwidth that enables to obtain <100 fs pulse duration in mode-locked regime of operation. Compared with other ytterbium-doped gain media with a similarly large gain bandwidth, ytterbium-doped tungstate has fairly high emission cross-sections. Ytterbium doping concentration in Yb:KGW crystals can be up to 5 at. % without a significant quenching. Thermal conductivity of common double tungstates is in the range of 3–4 $Wm^{-1}K^{-1}$. Yb:KGW crystals exhibit a small quantum defect and it is possible to operate with a quantum defect well below ~4-5%.

Main features

- Large gain bandwidth
- High emission cross-sections
- Small quantum defect
- High doping level
- High thermal conductivity
- Custom crystals available upon request

Application examples

- Femtosecond lasers and regenerative amplifiers
- CW and passively mode-locked thin-disk lasers

Standard specifications

YB:KGW CRYSTALS	
Orientation	Ng-cut; Np(b)-cut and other orientation available
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@970-1070 nm
Laser induced damage threshold	>10 J/cm²@1040 nm, 10 ns
Mount	Unmounted

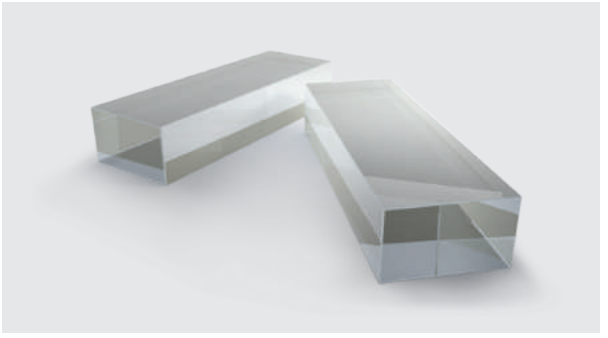
Properties

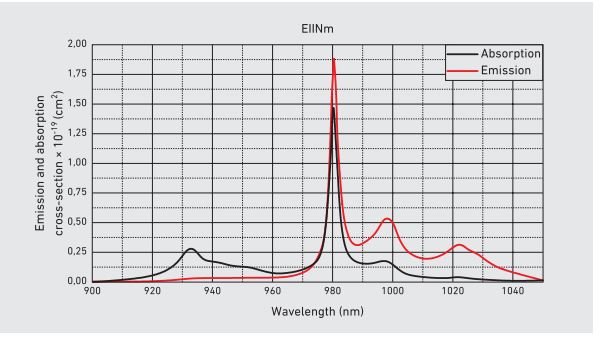
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	980 nm
Absorption cross-section at peak wavelength	12×10^{-20} cm^2 (E || N_m)
Absorption bandwidth at peak wavelength	3,7 nm
Laser wavelength	1025 (1020-1060) nm
Lifetime of $^2F_{5/2}$ ytterbium energy level	240 µs
Emission cross-section at 1030 nm	3×10^{-20} cm^2 (E || N_m)
Refractive index at 1064 nm	n_g = 2,037 n_p = 1,986 n_m = 2,033
Crystal structure	Monoclinic
Density	7,25 g/cm^3
Mohs hardness	4-5
Thermal conductivity	K_a = 2,6 Wm^{-1} K^{-1} K_b = 3,8 Wm^{-1} K^{-1} K_c = 3,4 Wm^{-1} K^{-1}
dn/dT	dn_p/dT = -15,7×10^{-6} K^{-1} dn_m/dT = -11,8×10^{-6} K^{-1} dn_g/dT = -17,3×10^{-6} K^{-1}
Thermal expansion coefficient	α_p = 1,7 × 10^{-6} K^{-1} α_m = 11,01 × 10^{-6} K^{-1} α_g = 17,37 × 10^{-6} K^{-1}
Typical doping level	1-5 at. %

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	10 mm	Brewster-angle cut	1%	Uncoated	7051	540 €
	10 mm	Right-angle cut	1%	AR/AR@970-1070 nm	7049	590 €
5 x 5 mm	10 mm	Brewster-angle cut	1%	Uncoated	7052	540 €
	10 mm	Right-angle cut	1%	AR/AR@970-1070 nm	7050	590 €
3 x 3 mm	5 mm	Brewster-angle cut	2%	Uncoated	7055	540 €
	5 mm	Right-angle cut	2%	AR/AR@970-1070 nm	7053	590 €
5 x 5 mm	5 mm	Brewster-angle cut	2%	Uncoated	7056	540 €
	5 mm	Right-angle cut	2%	AR/AR@970-1070 nm	7054	590 €
3 x 3 mm	3 mm	Brewster-angle cut	3%	Uncoated	7059	540 €
	3 mm	Right-angle cut	3%	AR/AR@970-1070 nm	7057	590 €
5 x 5 mm	3 mm	Brewster-angle cut	3%	Uncoated	7060	540 €
	3 mm	Right angle cut	3%	AR/AR@970-1070 nm	7058	590 €
3 x 3 mm	2 mm	Brewster-angle cut	5%	Uncoated	7063	540 €
	2 mm	Right-angle cut	5%	AR/AR@970-1070 nm	7061	590 €
5 x 5 mm	2 mm	Brewster-angle cut	5%	Uncoated	7064	540 €
	2 mm	Right-angle cut	5%	AR/AR@970-1070 nm	7062	590 €

Yb:KYW crystals





Yb^{3+}:KYW crystals possess a large gain bandwidth that enables to obtain <100 fs pulse duration in mode-locked regime of operation. Compared with other ytterbium-doped gain media with a similarly large gain bandwidth, ytterbium-doped tungstates have fairly high emission cross-sections. Ytterbium doping concentration in Yb:KYW crystals can be very high without a significant quenching. Thermal conductivity of common double tungstates is in the range of 3–4 $Wm^{-1}K^{-1}$. Yb:KYW crystals also feature a small quantum defect.

Main features

- Large gain bandwidth
- High emission cross-sections
- Small quantum defect
- High doping level
- High enough thermal conductivity
- Custom crystals available upon request

Application examples

- Femtosecond lasers and regenerative amplifiers
- CW and passively mode-locked thin-disk lasers

Standard specifications

YB:KYW CRYSTALS	
Orientation	Ng-cut; Np(b)-cut and other orientation available
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@970-1070 nm
Laser induced damage threshold	>10 J/cm²@1040 nm, 10 ns
Mount	Uncoated

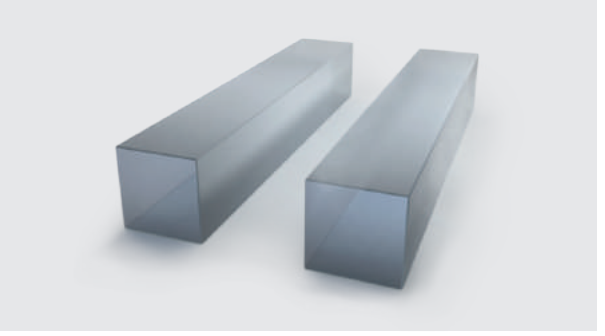
Properties

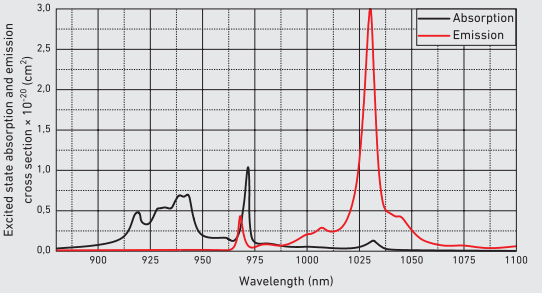
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	980 nm
Absorption cross-section at peak wavelength	14×10^{-20} cm^2 (E || N_m)
Absorption bandwidth at peak wavelength	~3 nm
Laser wavelength	1020 (1020-1050) nm
Lifetime of $^2F_{5/2}$ ytterbium energy level	230 µs
Emission cross-section at 1030 nm	$2,5 \times 10^{-20}$ cm^2 (E || N_m)
Refractive index at 1064 nm	n_g = 2,037 n_p = 1,986 n_m = 2,033
Crystal structure	Monoclinic
Density	6,61 g/cm^3
Mohs hardness	4-5
Thermal conductivity	~3,3 Wm-1K^{-1}
dn/dT	$dn_p/dT = -13,08 \times 10^{-6}$ K^{-1} $dn_m/dT = -7,61 \times 10^{-6}$ K^{-1} $dn_g/dT = -11,83 \times 10^{-6}$ K^{-1}
Thermal expansion coefficient	$\alpha_p = 1,9 \times 10^{-6}$ K^{-1} $\alpha_m = 10,3 \times 10^{-6}$ K^{-1} $\alpha_g = 16,5 \times 10^{-6}$ K^{-1}
Typical doping level	1-100 at. %

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	5 mm	Brewster-angle cut	2%	Uncoated	7037	540 €
	5 mm	Right-angle cut	2%	AR/AR@970-1070 nm	7035	590 €
5 x 5 mm	5 mm	Brewster-angle cut	2%	Uncoated	7038	540 €
	5 mm	Right-angle cut	2%	AR/AR@970-1070 nm	7036	590 €
3 x 3 mm	2 mm	Brewster-angle cut	5%	Uncoated	7039	540 €
	2 mm	Right-angle cut	5%	AR/AR@970-1070 nm	7041	590 €
5 x 5 mm	2 mm	Brewster-angle cut	5%	Uncoated	7042	540 €
	2 mm	Right-angle cut	5%	AR/AR@970-1070 nm	7040	590 €
3 x 3 mm	1 mm	Brewster-angle cut	10%	Uncoated	7045	540 €
	1 mm	Right-angle cut	10%	AR/AR@970-1070 nm	7043	590 €
5 x 5 mm	1 mm	Brewster-angle cut	10%	Uncoated	7046	540 €
	1 mm	Right-angle cut	10%	AR/AR@970-1070 nm	7044	590 €

Yb:YAG crystals





Yb^{3+}:YAG crystals feature a 950 us lifetime of the $^2F_{5/2}$ ytterbium energy level and a quantum defect of only ~9%. Yb:YAG crystals also possess a broad pump band at near 940 nm that is more than 10 times broader than the 808 nm pump line of Nd:YAG crystals. It makes Yb:YAG systems less sensitive to thermal shift of pump diodes wavelength. Yb:YAG lasers emit typically at either 1030 nm (strongest line) or 1050 nm. It is often used in powerful and efficient thin-disk lasers.

Main features

- Simple electronic structure excludes excited-state absorption and also a variety of detrimental quenching processes
- Broad absorption band at 940 nm
- Long lifetime of the $^2F_{5/2}$ ytterbium energy level
- Low quantum defect
- Custom crystals available upon request

Application examples

- Material processing, micromachining, welding, cutting
- Efficient high power thin-disk lasers

Standard specifications

YB:YAG CRYSTALS	
Orientation	[111]
Extinction ratio	>28 dB
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Wavefront distortion	λ/4@632,8 nm
Coatings	AR(R<0,5%)@940 nm + AR(R<0,2%)@1030 nm on both faces
Laser induced damage threshold	>10 J/cm²@1030 nm, 10 ns
Mount	Unmounted

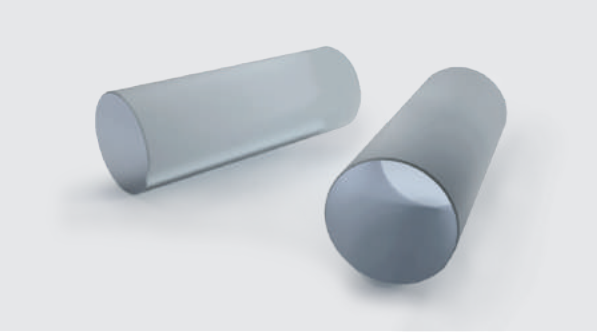
Properties

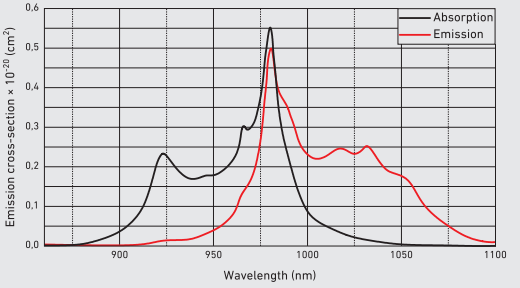
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	942 nm
Absorption cross-section at peak wavelength	$7{,}7 \times 10^{-21}$ cm^2
Absorption bandwidth at peak wavelength	18 nm
Laser wavelength	1030 nm
Lifetime of $^2F_{5/2}$ ytterbium energy level	950 µs
Emission cross-section @1030 nm	$2{,}1 \times 10^{-20}$ cm^2
Refractive index @632,8 nm	1,83
Crystal structure	Cubic
Density	4,56 g/cm^3
Mohs hardness	8,5
Thermal conductivity	~13 Wm^{-1} K^{-1}
dn/dT	$7{,}8 \times 10^{-6}$ K^{-1}
Thermal expansion coefficient	$6{,}2 \times 10^{-6}$ K^{-1}
Typical doping level	1-20 at. %

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
5 x 5 mm	10 mm	Brewster-angle cut	1%	Uncoated	6664	500 €
		Right-angle cut	1%	AR/AR@940 nm + 1030 nm	6661	540 €
	2 mm	Brewster-angle cut	5%	Uncoated	6663	500 €
		Right-angle cut	5%	AR/AR@940 nm + 1030 nm	6660	540 €
	1 mm	Brewster-angle cut	10%	Uncoated	6662	500 €
		Right-angle cut	10%	AR/AR@940 nm + 1030 nm	6659	540 €

Yb:CaF_2 crystals





Yb^{3+}:CaF_2 are among most studied and promising crystals for the development of short-pulse, high-energy, high-power diode-pumped solid-state lasers. There are several reasons that explain this trend. Firstly, calcium fluoride is a simple cubic crystal whose crystallographic properties are fairly well known.

Moreover, this crystal can be grown of large dimension and optical quality. The simple structure of this crystal contributes to its good thermal properties. Finally, Yb-doped calcium fluorides feature very broad and smooth emission bands, which is exceptional for cubic crystals.

Main features

- Isotropic crystal (cubic symmetry)
- Low quantum defect
- Long lifetime of the $^2F_{5/2}$ ytterbium energy level
- Wide optical transmission
- Low dispersion behavior
- Limited nonlinear effects under intense laser irradiation
- Custom crystals available upon request

Application examples

- Diode-pumped femtosecond solid-state lasers aiming at the generation of high-energy pulses
- Ultrashort pulses with high average power

Standard specifications

YB:CAF_2 CRYSTALS	
Orientation	[111]
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@980 nm + AR(R< 0,35%)@1040-1070 nm
Laser induced damage threshold	>10 J/cm^2@1040 nm, 10 ns
Mount	Unmounted

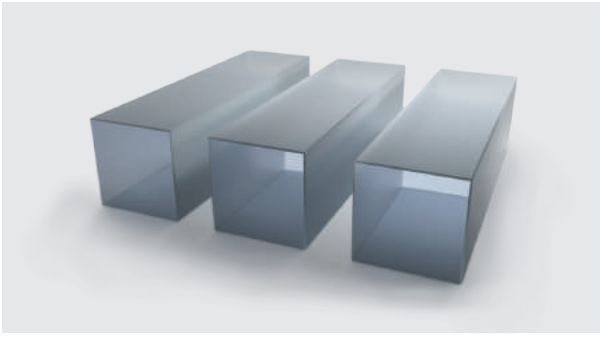
Properties

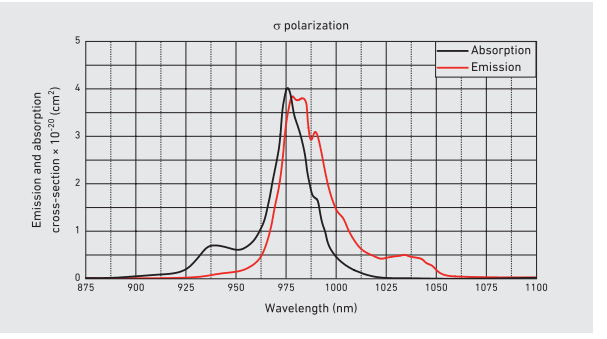
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	976 nm
Absorption cross-section at peak	$0{,}54 \times 10^{-20}$ cm^2
Laser wavelength	1020-1060 nm
Lifetime of $^2F_{5/2}$ energy level	2,4 ms
Emission cross-section @1053 nm	$0{,}16 \times 10^{-20}$ cm^2
Refractive index @1040nm	1,43
Crystal structure	cubic
Density	3,18 g/cm^3
Mohs hardness	4
Thermal conductivity	5,4 Wm^{-1}K^{-1}
dn/dT	$-11{,}3 \times 10^{-6}$ K^{-1}
Thermal expansion coefficient	$18{,}9 \times 10^{-6}$ K^{-1}
Typical doping level	1-5 at. %

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
ø3 mm	10 mm	Brewster-angle cut	1%	Uncoated	7032	540 €
		Right-angle cut	1%	AR/AR@980 nm + 1040-1070 nm	7029	590 €
	5 mm	Brewster-angle cut	3%	Uncoated	7031	540 €
		Right-angle cut	3%	AR/AR@980 nm + 1040-1070 nm	7028	590 €
	3 mm	Brewster-angle cut	5%	Uncoated	7030	540 €
		Right-angle cut	5%	AR/AR@980 nm + 1040-1070 nm	7027	590 €

Yb:YAB crystals





Yb^{3+}:YAB is one of the few representatives with multifunctional properties: as a negative uniaxial crystal, it also possesses nonlinear optical properties, permitting a direct conversion of the infrared radiation to the visible through second order nonlinear processes.

High concentrations of Yb^{3+} ions can be included in the YAB crystal matrix with little concentration quenching. Yb:YAB crystals feature good mechanical strength, good thermal conductivity, and stable chemical characteristics.

Main features

- Self-doubling laser crystal
- High thermal conductivity
- Wide absorption bandwidth near 976 nm
- High absorption and emission cross-sections
- Low quantum defect
- Custom crystals available upon request

Application examples

- High power CW lasers
- Mode-locked femtosecond lasers
- CW and mode-locked self-doubling lasers

Standard specifications

YB:YAB CRYSTALS	
Orientation	c-cut, a-cut available
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	Antireflective (AR) coatings on both faces
Laser induced damage threshold	>10 J/cm²@1030 nm, 10 ns (for AR/AR@960-1060 nm coatings)
Mount	Unmounted

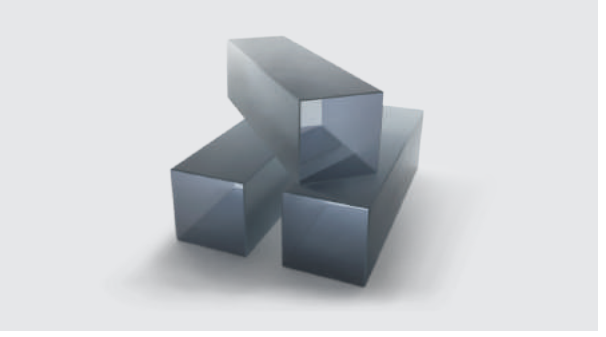
Properties

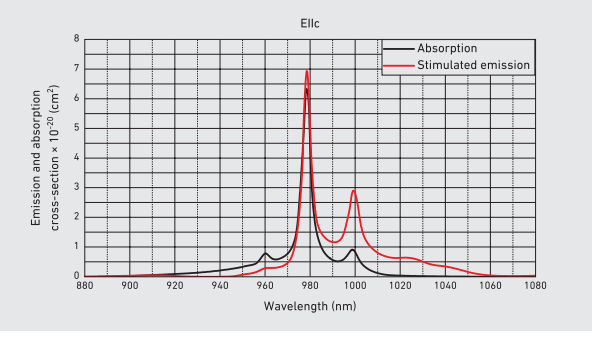
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	976 nm
Absorption cross-section at peak	$3{,}8 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	20 nm
Laser wavelength	1040 nm
Lifetime of $^2F_{5/2}$ energy level	680 µs
Emission cross-section @1040 nm	$0{,}5 \times 10^{-20}$ cm^2
Refractive index @632.8 nm	n_o=1,7757, n_e=1,7015
Crystal structure	Trigonal
Density	3,84 g/cm^3
Mohs hardness	7,5
Thermal conductivity	~6 Wm^{-1}K^{-1}
dn/dT	$1{,}4 \times 10^{-6}$ (IIa) K^{-1}, $4{,}8 \times 10^{-6}$ (IIc) K^{-1}
Thermal expansion coefficient	2×10^{-6} (IIa) K^{-1}, $9{,}5 \times 10^{-6}$ (IIc) K^{-1}
Typical doping level	10 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	ORIENTATION	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	2 mm	Right-angle cut	c-cut	10%	AR/AR@960-1060 nm	12826	Request
		Brewster-angle cut	c-cut	10%	Uncoated	12827	Request
		Right-angle cut	θ = 31°, ϕ = 0°	10%	AR/AR@520+976+1040 nm	12828	Request

Yb:YAP crystals





Yttrium aluminate doped with Yb^{3+}, (Yb^{3+}YAP) is a biaxial orthorhombic crystal. YAP crystal hardness and thermal conductivity are similar to YAG but exhibits a highly anisotropic thermal expansion coefficient and is birefringent. Emission wavelengths are polarized, while emission and absorption cross-sections are strongly dependent upon the crystallographic orientation. The absorption cross-sections of the Yb:YAP crystal is higher than that of the Yb:YAG crystal.

Main features

- Biaxial orthorhombic crystal
- High absorption cross-section dependent upon the crystallographic orientation
- High thermal conductivity
- Low quantum defect
- Custom crystals available upon request

Application examples

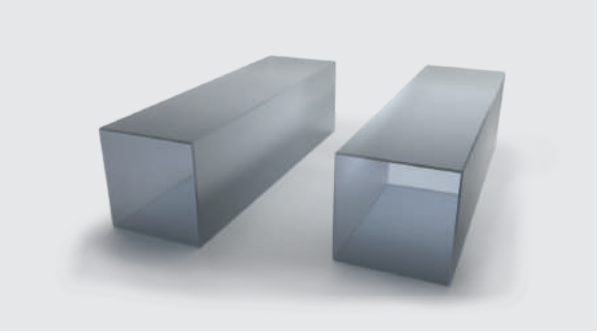
- Femtosecond lasers and regenerative amplifiers
- CW and passively mode-locked thin-disk lasers

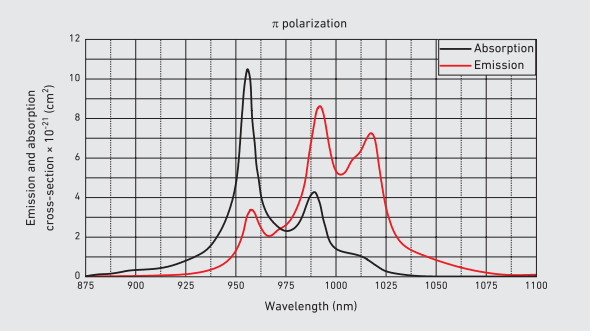
Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	978 nm
Absorption cross-section at peak	$6{,}6 \times 10^{-20}$ cm²
Absorption bandwidth at peak wavelength	4 nm
Laser wavelength	1040 nm
Lifetime of $^2F_{5/2}$ energy level	500 µs
Emission cross-section @1040 nm	$0{,}5 \times 10^{-20}$ cm²
Refractive index @632.8 nm	1,96 (IIa), 1,94 (IIb), 1,97 (IIc)
Crystal structure	orthorhombic
Density	5,35 g/cm³
Mohs hardness	8,5
Thermal conductivity	11,7 (IIa), 10,0 (IIb), 13,3 (IIc) $Wm^{-1}K^{-1}$
dn/dT	$7{,}7 \times 10^{-6}$ (IIa) K^{-1}, $11{,}7 \times 10^{-6}$ (IIb) K^{-1}, $8{,}3 \times 10^{-6}$ (IIc) K^{-1}

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Thermal expansion coefficient	$2{,}32 \times 10^{-6}$ (IIa) K^{-1}, $8{,}08 \times 10^{-6}$ (IIb) K^{-1}, $8{,}7 \times 10^{-6}$ (IIc) K^{-1}
Typical doping level	<2 at.%

$Yb^{3+}:Ca_4GdO(BO_3)_3$ laser crystals. Also, the YLF crystal is favorable when high ytterbium ion dopant concentrations are desired.





Main features

- Simple electronic structure excludes excited-state absorption and
- Broad and smooth emission spectrum
- Wide tunning range
- Absorption spectra are well matched with the emission wavelength
- Low quantum defect
- Custom crystals available upon request

Application examples

- Diode-pumped mode-locked lasers
- Thin-disk lasers

Standard specifications

YB:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@960 nm + AR(R< 0,2%) @1000-1060 nm on both faces
Laser induced damage threshold	>10 J/cm²@1030 nm, 10 ns
Mount	Unmounted

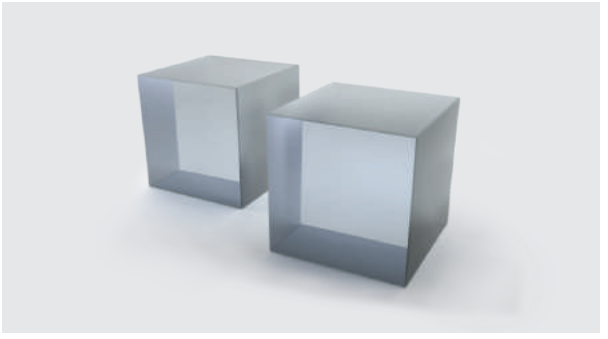
Properties

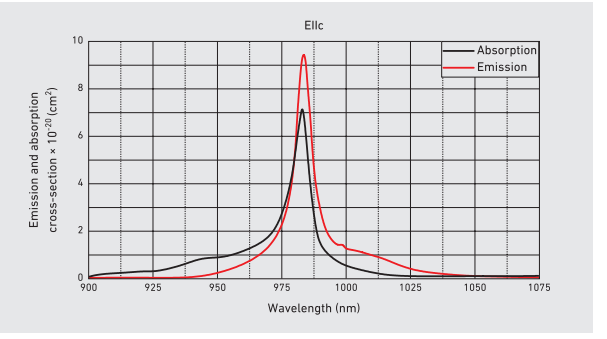
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	960 nm
Absorption cross-section at peak	$10{,}5 \times 10^{-21}$ cm^2
Absorption bandwidth at peak wavelength	~10 nm
Laser wavelength	1017 nm
Lifetime of $^2F_{5/2}$ energy level	2,1 ms
Emission cross-section @1053 nm	$4{,}1 \times 10^{-21}$ cm^2
Refractive index @1040nm	~1,4
Crystal structure	tetragonal
Density	3,95 g/cm^3
Mohs hardness	5
Thermal conductivity	6 Wm^{-1}K^{-1}
dn/dT	$-4{,}6 \times 10^{-6}$ (IIc) K^{-1}, $-6{,}6 \times 10^{-6}$ (IIa) K^{-1}
Thermal expansion coefficient	8×10^{-6} (IIc) K^{-1}, 13×10^{-6} (IIa) K^{-1}
Typical doping level	5-20 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	8 mm	Right-angle cut	5%	AR/AR@960 nm + 1000-1060 nm	7828	590 €
3 x 3 mm	8 mm	Brewster-angle cut	5%	Uncoated	7829	540 €
ø8 mm	8 mm	Right-angle cut	5%	AR/AR@960 nm + 1000-1060 nm	7830	680 €
3 x 3 mm	4 mm	Brewster-angle cut	10%	Uncoated	7832	540 €
3 x 3 mm	4 mm	Right-angle cut	10%	AR/AR@960 nm + 1000-1060 nm	7831	590 €
ø8 mm	4 mm	Right-angle cut	10%	AR/AR@960 nm + 1000-1060 nm	7833	680 €
3 x 3 mm	2 mm	Brewster-angle cut	20%	Uncoated	7835	540 €
3 x 3 mm	2 mm	Right-angle cut	20%	AR/AR@960 nm + 1000-1060 nm	7834	590 €
ø8 mm	2 mm	Right-angle cut	20%	AR/AR@960 nm + 1000-1060 nm	7836	680 €

Yb:YVO_4 crystals





Yb^{3+}:YVO_4 crystal has a broad and smooth emission spectrum that allows wide wavelength tuning ranges and generating ultrashort pulses in mode-locked lasers. Due to good thermal conductivity

Yb:YVO_4 crystals can be used as an active medium in high-power thin-disk lasers.

Main features

- The simple electronic structure excludes excited-state absorption and also a variety of detrimental quenching processes
- Broad and smooth emission spectrum
- Low quantum defect
- Custom crystals available upon request

Application examples

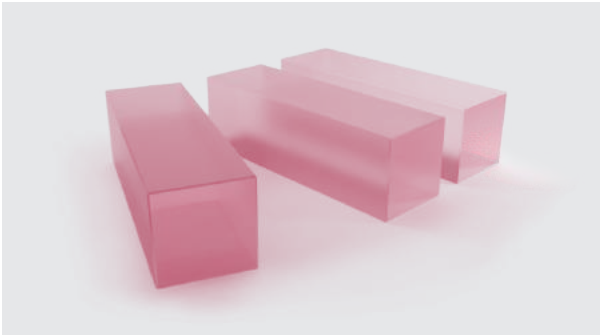
- High power CW, Q-switched and mode-locked lasers
- Thin-disk lasers

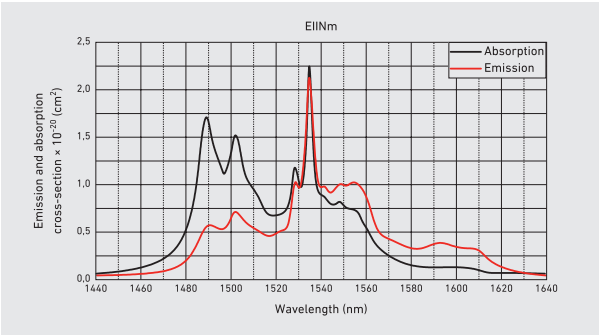
4Lasers does not provide standard product list. Please contact us for solutions and pricing.

Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	985 nm
Absorption cross-section at peak	$7,5 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	5 nm
Laser wavelength	1027 nm
Lifetime of $^2F_{5/2}$ ytterbium energy level	250 µs
Emission cross-section @1027 nm	$0,5 \times 10^{-20}$ cm^2
Refractive index @1064 nm	$n_o = 1,93$, $n_e = 2,1$
Crystal structure	Tetragonal
Density	4,22 g/cm^3
Mohs hardness	5
Thermal conductivity	~5 $Wm^{-1}K^{-1}$
dn/dT	$8,41 \times 10^{-6}$ (IIc) K^{-1}, $15,5 \times 10^{-6}$ ((IIa) K^{-1}
Thermal expansion coefficient	$1,5 \times 10^{-6}$ (IIa) K^{-1}, $8,2 \times 10^{-6}$ (IIc) K^{-1}
Typical doping level	1-3 at.%

Er:KYW crystals





Er^{3+}:KYW is a promising laser material for eye-safe emission at the wavelength of 1609 nm, which can be resonantly diode-pumped into the upper laser manifold at 1534 nm. Due to the low quantum defect high-slope efficiencies of >80% can be achieved with direct fiber laser or InGaAs/InP pumping. Because of a broad and smooth emission in the spectral range of 1570-1630 nm mode-locked "eye-safe" laser can be realized.

Main features

- Strong absorption bandwidth near 1534 nm corresponding to InGaAsP/InP laser diode emission
- Wide emission bandwidth near 1600 nm
- Custom crystals available upon request

Application examples

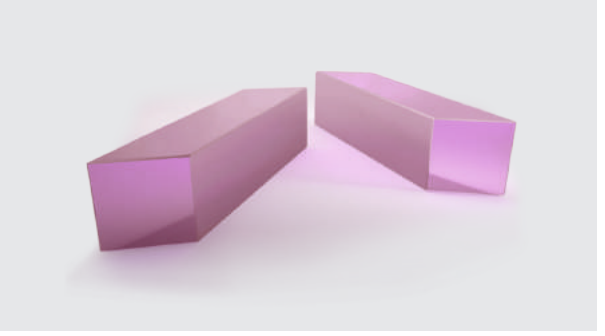
- In-band pumped "eye-safe" CW, Q-switched and mode-locked lasers
- In-band pumped "eye-safe" waveguide lasers

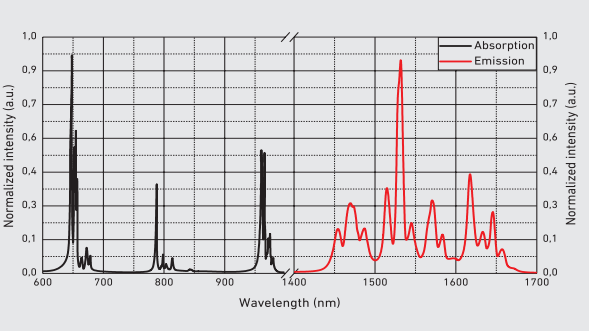
4Lasers does not provide standard product list. Please contact us for solutions and pricing.

Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	1534 nm
Absorption cross-section at peak	$2,4 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	3 nm
Laser wavelength	1609 nm
Lifetime of $^4I_{13/2}$ erbium energy level	3,1 ms
Emission cross-section @1609 nm	$0,4 \times 10^{-20}$ cm^2
Refractive index	$n_g = 2,05$, $n_m = 2,01$, $n_p = 1,97$
Crystal structure	Monoclinic
Density	6,5 g/cm^3
Mohs hardness	4-5
Thermal conductivity	~3,5 Wm^{-1}K^{-1}
Typical doping level	<20 at. %

Er:YAG crystals





Er^{3+}:YAG crystal is an attractive laser material for eye-safe emission at wavelengths of 1617 and 1645 nm which can be resonantly diode-pumped into the upper laser manifold at 1470 nm and 1532 nm. Due to the low quantum defect high slope efficiencies of >80% can be achieved with direct fiber laser or InGaAs/InP pumping. By using heavily erbium doped (~50 at.%) YAG crystal efficient CW laser operation at ~3 µm can be obtained.

Main features

- Isotropic crystal (cubic symmetry)
- High thermal conductivity
- Strong absorption bandwidth near 1470 nm corresponding to InGaAsP/InP laser diode emission
- Emission spectra at 1617 nm is free from absorption in the atmosphere
- Custom crystals available upon request

Application examples

- CW and Q-switched eye-safe (~1,6 µm) in-band pumped lasers with nearly quantum defect limited efficiency for military applications including LIDAR, telemetry, or active imaging
- Channel waveguide eye-safe (~1,6 µm) in-band pumped lasers with diffraction-limited output for long-distance telemetry and ranging
- CW and Q-switched ~3 µm lasers for oral surgery, dentistry, implant dentistry, and otolaryngology

Standard specifications

ER:YAG CRYSTALS	
Orientation	[111]
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	Uncoated, coatings available upon request
Mount	Unmounted

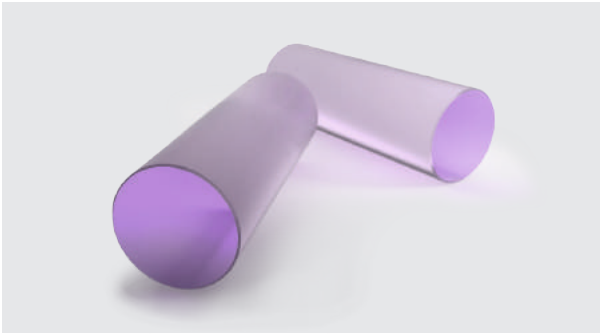
Properties

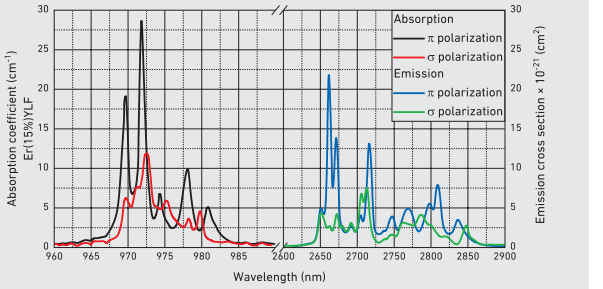
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	960, 1470, 1532 nm
Absorption cross-section at peak wavelength	~1,0 × 10^{-20} cm^2@1470 nm
Absorption bandwidth at peak wavelength	~2-3 nm @ 1470 nm
Laser wavelength	1617, 1645, 2940 nm
Lifetime of $^4I_{13/2}$ and $I_{11/2}$ erbium energy level	6,0 ms ($^4I_{13/2}$), 0,1 ms ($I_{11/2}$)
Emission cross-section at wavelength	2,6 × 10^{-20}@2940 nm 5,2 × 10^{-21}@1645 nm
Refractive index @1064 nm	1,82
Crystal structure	Cubic
Density	4,56 g/cm^3
Mohs hardness	8,5
Thermal conductivity	~13 $Wm^{-1}K^{-1}$
dn/dT @1064 nm	7,8 × 10^{-6} K^{-1}
Thermal expansion coefficient	~7 × 10^{-6} K^{-1}
Typical doping level	<1 at.% (for ~1,6 µm lasers) <50 at.% (for ~3 µm lasers)

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
5 x 5 mm	3 mm	Brewster-angle cut	0,15%	Uncoated	7852	Request
	2 mm	Brewster-angle cut	50%	Uncoated	7853	500 €

Er:YLF crystals





Er^{3+}:YLF crystals are characterized by a low phonon frequency, which decreases the probability of non-radiative multi-phonon relaxations, therefore increases the luminescence quantum efficiency. Long lifetime of laser emitting levels allow higher energy storage, which is useful for the Q-switch lasing regime. High bandgap along with a low phonon energy leads to a very wide transparency range, which is possibly from VUV to 10 µm region. Negative Er^{3+}:YLF thermo-optic coefficient is an advantage since it reduces the thermal-lensing effect and improves beam shape as well as stability at high average pump power.

Main features

- A low phonon frequency
- Long lifetimes of the laser emitting levels
- Wide transparency range (from the VUV to the 10 µm region)
- Negative thermo-optic coefficient
- Custom crystals available upon request

Application examples

- CW and Q-switched ~3 µm lasers for oral surgery, dentistry, implant dentistry, and otolaryngology
- Up-conversion visible lasers for display technology, medicine (diagnosis and treatment)

Standard specifications

ER:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	Uncoated, coatings available upon request
Mount	Unmounted

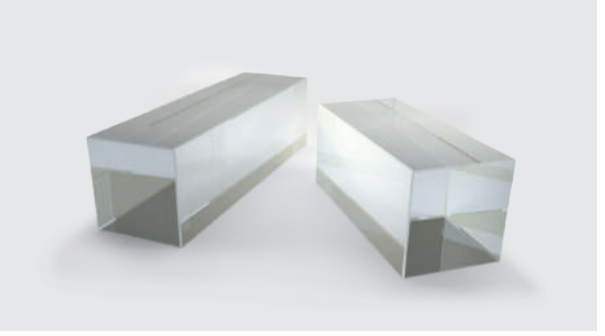
Properties

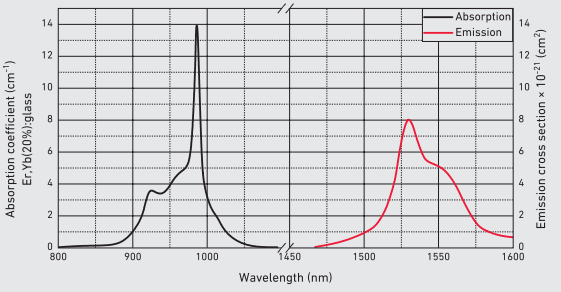
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	972 nm
Absorption coefficient at peak wavelength	28 cm^{-1}
Absorption bandwidth at peak wavelength	~1 nm
Laser wavelength	2810 nm
Lifetime of $^4I_{11/2}$ erbium energy level	4 ms
Emission cross-section @2800 nm	1,5 × 10^{-20} cm^2
Refractive index @2070 nm	n_o = 1,442, n_e = 1,464
Crystal structure	tetragonal
Density	3,95 g/cm^3
Mohs hardness	5
Thermal conductivity	~5 $Wm^{-1}K^{-1}$
dn/dT	-2 × 10^{-6} (IIa) K^{-1}, -4,1×10^{-6} (IIc) K^{-1}
Thermal expansion coefficient	8 × 10^{-6} K^{-1}
Typical doping level	15 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
ø5 mm	5 mm	Brewster-angle cut	15%	Uncoated	7843	540 €
5 x 5 mm	5 mm	Brewster-angle cut	15%	Uncoated	7842	540 €

Er, Yb:phosphate glass





Er^{3+},Yb^{3+} co-doped phosphate glass (Er,Yb:phosphate glass) is a well-known and commonly used active medium for lasers emitting in the "eye-safe" spectral range of 1,5-1,6 µm. Phosphate glass combines a long lifetime (~8 ms) of $^4I_{13/2}$ Er^{3+} upper laser level with a low (2–3 ms) lifetime of $^4I_{11/2}Er^{3+}$ level that is in resonance with Yb^{3+} $^2F_{5/2}$ excited state. Fast non-radiative multi-phonon relaxation from $^4I_{11/2}$ to $^4I_{13/2}$ level greatly decreases the back-energy transfer and up-conversion losses due to the interaction between Yb^{3+} and Er^{3+} ions, excited at the $^2F_{5/2}$ and the $^4I_{11/2}$ levels, respectively.

Main features

- Long lifetime of the $^4I_{13/2}$ erbium energy level
- High Yb to Er energy transfer efficiency
- High absorption and emission cross-sections
- Wide absorption and emission bandwidths
- Custom crystals available upon request

Application examples

- Passively Q-switched lasers for laser rangefinders, LIDAR, and LIBS systems

Standard specifications

ER, YB:PHOSPHATE GLASS ELEMENTS	
Clear aperture	>90%
Face dimensions tolerance	+0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@940 nm + AR(R<0,2%) @1535 nm on both faces
Laser induced damage threshold	>10 J/cm²@1535 nm, 10 ns
Mount	Unmounted

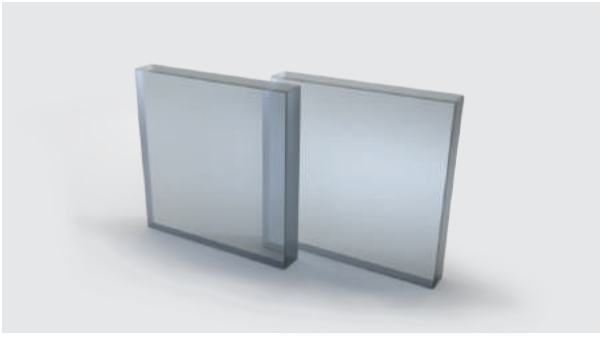
Properties

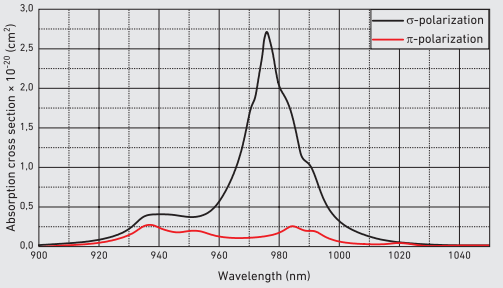
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	970 nm
Absorption cross-section at peak wavelength	$1,7 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	20 nm
Laser wavelength	1534 nm
Lifetime of $^4I_{13/2}$ erbium energy level	7,9 ms
Emission cross-section @1534 nm	8×10^{-21} cm^2
Yb to Er energy transfer efficiency	>90 %
Refractive index @1534 nm	1,52
Crystal structure	-
Density	2,93 g/cm^3
Mohs hardness	6-7
Thermal conductivity	0,85 $Wm^{-1}K^{-1}$
dn/dT	$-2,1 \times 10^{-6}$ K^{-1}
Thermal expansion coefficient	$12,4 \times 10^{-6}$ K^{-1}
Typical doping level	$0,3\text{-}1,3 \times 10^{20}$ cm^{-3} [Er] $1,7\text{-}4 \times 10^{21}$ cm^{-3} [Yb]

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	5 mm	Brewster-angle cut	Yb 20%, Er 1%	Uncoated	7824	370 €
		Right-angle cut	Yb 20%, Er 1%	AR/AR@940 nm + 1535 nm	7823	395 €
	10 mm	Brewster-angle cut	Yb 20%, Er 0,5%	Uncoated	7822	370 €
		Right-angle cut	Yb 20%, Er 0,5%	AR/AR@940 nm + 1535 nm	7821	395 €

Er, Yb:YAB crystals





Er^{3+}, Yb^{3+} co-doped yttrium-aluminum borate (Er, Yb:YAB) crystal is an alternative to commonly used Er,Yb:phosphate glass as an active medium of "eye-safe" (1,5-1,6 µm) lasers with a high average output power in CW and pulsed modes. It is characterized by high thermal conductivities of 7,7 $Wm^{-1}K^{-1}$ and 6 $Wm^{-1}K^{-1}$ along a-axis and c-axis, respectively. It also features a highly effective Yb^{3+} to Er^{3+} energy transfer (~94%) and weak up conversion losses due to the very short lifetime of $^4I_{11/2}$ excited state (~80 ns) facilitated by a high maximum phonon energy of the host material (hv_{max} ~1500 cm^{-1}). A strong and wide (~17 nm) absorption band is observed at 976 nm that coincides with the emission spectrum of InGaAs laser diodes.

Main features

- Uniaxial crystal with trigonal structure
- High thermal conductivity
- Wide absorption bandwidth near 976 nm
- High absorption and emission cross-sections
- Extremely high Yb^{3+} to Er^{3+} energy transfer efficiency

Application examples

- High power eye-safe (~1,5 µm) CW lasers for metrology
- High-repetition rate passively Q-switched lasers for LIDAR and LIBS systems
- Ultrashort mode-locked lasers for telecom systems

Standard specifications

ER, YB:YAB CRYSTALS	
Orientation	c-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR@(R<1%)@940 nm + AR(R<0,25%)@1480-1600 nm
Laser induced damage threshold	>10 J/cm²@1550 nm, 10 ns
Mount	Unmounted

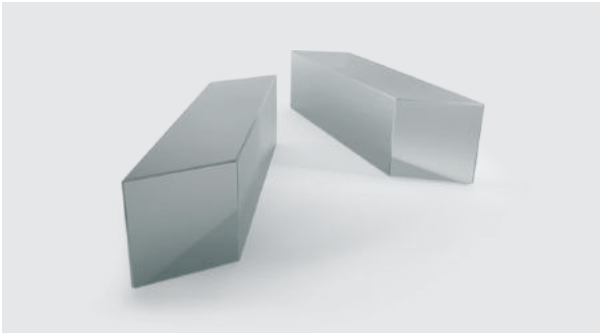
Properties

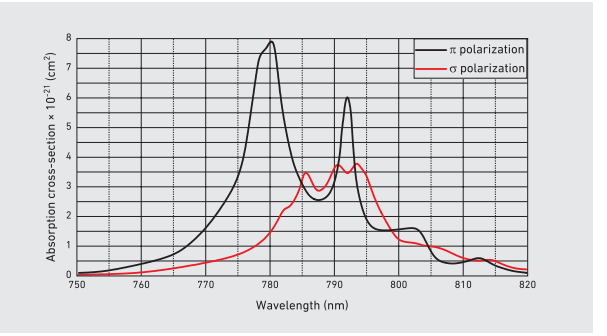
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	976 nm
Absorption cross-section at peak wavelength	$2,7 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	17 nm
Laser wavelength	1522, 1531, 1543, 1550, 1602 nm
Lifetime of $^4I_{13/2}$ erbium energy level	0,32 ms
Emission cross-section @1531 nm	$2,5 \times 10^{-20}$ cm^2
Yb to Er energy transfer efficiency	>90 %
Refractive index @632.8 nm	$n_o = 1,7757$, $n_e = 1,7015$
Crystal structure	trigonal
Density	3,84 g/cm^3
Mohs hardness	7,5
Thermal conductivity	7,7 (IIa), 6 (IIc) $Wm^{-1}K^{-1}$
dn/dT	$1,4 \times 10^{-6}$ (IIa), $4,8 \times 10^{-6}$ (IIc) K^{-1}
Thermal expansion coefficient	2×10^{-6} (IIa), $9,5 \times 10^{-6}$ (IIc) K^{-1}
Typical doping level	1-2 at.% [Er] 8-15 at.% [Yb]

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	1 mm	Brewster-angle cut	12% Yb, 1,5% Er	Uncoated	7068	540 €
		Right-angle cut	12% Yb, 1,5% Er	AR/AR@976 nm + 1480-1600 nm	7065	590 €
	2 mm	Brewster-angle cut	12% Yb, 1,5% Er	Uncoated	7069	540 €
		Right-angle cut	12% Yb, 1,5% Er	AR/AR@976 nm + 1480-1600 nm	7066	590 €
	3 mm	Brewster-angle cut	12% Yb, 1,5% Er	Uncoated	7070	540 €
		Right-angle cut	12% Yb, 1,5% Er	AR/AR@976 nm + 1480-1600 nm	7067	590 €

Tm:YLF crystals





Tm^{3+}:YLF crystal features high absorption peaks conveniently located for diode pumping around 792 nm and exhibits a cross-relaxation process, which creates two ions in the upper laser level for each pump photon absorbed. Tm^{3+}:YLF lasers are ideal pump sources for Ho^{3+}:YAG lasers. This is due to a good overlap of Tm^{3+}:YLF emission and Ho^{3+}:YAG absorption spectra and capacity of producing linearly polarized output. What is more, the refractive index of Tm^{3+}:YLF decreases with temperature, leading to a negative thermal lens that is partly compensated by a positive lens effect due to end face bulging.

Main features

- Strong absorption bands for laser diode pumping
- Weak thermal lensing
- High polarization purity
- Custom crystals available upon request

Application examples

- LIDAR systems for remote sensing applications
- Pump source for Ho^{3+}:YAG lasers

Standard specifications

TM:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@792 nm + AR(R< 0,5%) @1800-1960 nm on both faces
Laser induced damage threshold	>10 J/cm²@1900 nm, 10 ns
Mount	Unmounted

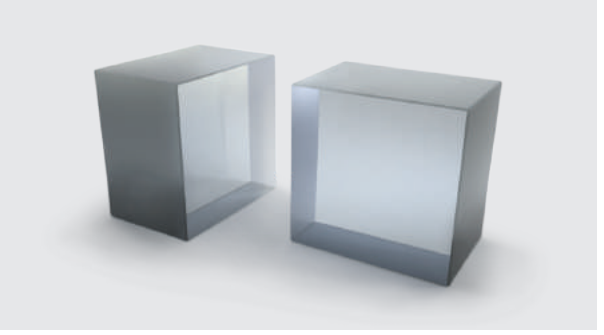
Properties

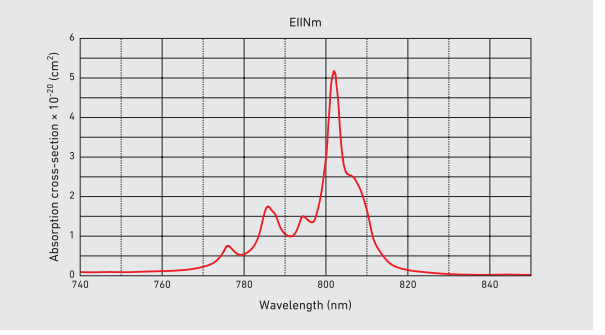
SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	792 nm
Absorption cross-section at peak	$0{,}55 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	16 nm
Laser wavelength	1900 nm
Lifetime of $^3F_4$ thulium energy level	16 ms
Emission cross-section @1900 nm	$0{,}4 \times 10^{-20}$ cm^2
Refractive index @1064 nm	n_o = 1,448, n_e = 1,470
Crystal structure	tetragonal
Density	3,95 g/cm^3
Mohs's hardness	5
Thermal conductivity	6 Wm^{-1}K^{-1}
dn/dT	$-4{,}6 \times 10^{-6}$ (IIc) K^{-1}, $-6{,}6 \times 10^{-6}$ (IIa) K^{-1}
Thermal expansion coefficient	$10{,}1 \times 10^{-6}$ (IIc) K^{-1}, $14{,}3 \times 10^{-6}$ (IIa) K^{-1}
Typical doping level	2-4 at.%

Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	8 mm	Brewster-angle cut	3%	Uncoated	7817	540 €
		Right-angle cut	3%	AR/AR@792 nm + 1800-1960 nm	7816	590 €

Tm:KYW crystals





Double tungstate crystals are optically biaxial and their optical properties have to be described within the frame of optical indicatrix axes (Np, Nm and Ng). Advantages of Tm-doped KYW crystals include a broad fluorescence band, a large emission cross section and a relatively low upper level lifetime. Such combination of properties is very promising for generation of femtosecond pulses in solid-state laser systems.

Main features

- Broad fluorescence band
- Large emission cross-section
- Relatively low upper-level lifetime
- Custom crystals available upon request

Application examples

- CW and Q-switched lasers emitting near 2 µm for application in surgery, range finding and environmental monitoring
- 2 µm wavelength region femtosecond lasers

Standard specifications

TM:KYW CRYSTALS	
Orientation	N_g-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@802 nm + AR(R< 0,5%) @1900-2000 nm on both faces
Laser induced damage threshold	>10 J/cm^2@1900 nm, 10 ns
Mount	Unmounted

Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	802 nm
Absorption cross-section at peak	$5{,}2 \times 10^{-20}$ cm^2
Absorption bandwidth at peak wavelength	5,5 nm
Laser wavelength	1910 nm
Lifetime of $^3F_4$ energy level	1,1 ms
Emission cross-section @1910 nm	$1{,}15 \times 10^{-20}$ cm^2
Refractive index @1040nm	n_g = 2,05, n_m = 2,01, n_p = 1,97
Crystal structure	Monoclinic
Density	6,5 g/cm^3
Mohs hardness	4-5
Thermal conductivity	~3,3 Wm^{-1}K^{-1}
dn/dT	$dn_m/dT = -9{,}2 \times 10^{-6}$ K^{-1}
Thermal expansion coefficient	α_p=1,83 × 10^{-6}K^{-1}, α_m=10,29 × 10^{-6}K^{-1}, α_g=15,94 × 10^{-6}K^{-1}
Typical doping level	~5 at.%

Standard products

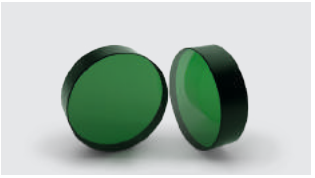
FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU	PRICE
3 x 3 mm	2 mm	Brewster-angle cut	5%	Uncoated	7841	Request
		Right-angle cut	5%	AR/AR@802 nm +1900-2000 nm	7840	Request

Passive q-switch crystals

Passive Q-switch crystals (saturable absorbers) are used as laser resonator quality modulators in passively Q-switched lasers instead of electrically controlled modulators. Typically, these saturable absorbers are characterized by a low saturation fluence (saturation energy per unit area) and their use with converging beams can further reduce the saturation energy (saturation fluence times beam area).

4Lasers develops and supplies different passive Q-switch crystal hosts and ion dopant combinations for research and industrial applications, therefore custom solutions are available upon request.

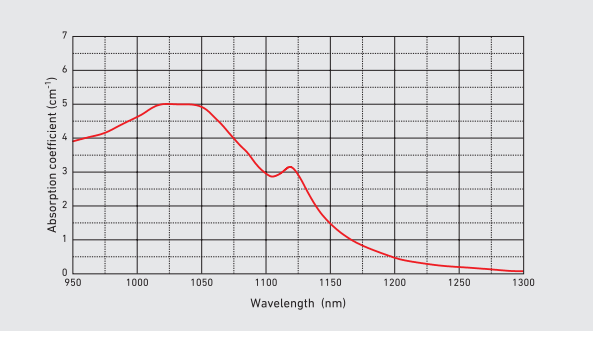
Cr:YAG crystals



V:YAG crystals

Co:Spinel crystals

Cr:YAG crystals



Cr^{4+}:YAG crystals are ideal for passive Q-switch operation of Nd:YAG and other Nd^{3+} or Yb^{3+} doped laser crystals in the wavelength range of 900 nm to 1200 nm. Remarkable feature of Cr^{4+}:YAG is the high damage threshold of >10 J/cm^2@1064 nm, 10 ns. Its absorption band extends from 900 nm to 1200 nm and peaks around 1060 nm with a very large absorption cross-section.

Main features

- Good chemical stability and reliability
- Long lifetime and good thermal conductivity
- Easy to operate
- Custom crystals available upon request

Application examples

- Passively Q-switched lasers for laser rangefinders, LIDAR and LIBS systems
- Laser systems where short pulses are required

Standard specifications

CR:YAG CRYSTALS	
Initial transmission T_0	5-99 %@1064 nm
Initial transmission T_0 tolerance	±1% (for values larger than 80 %)
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Parallelism error	<10 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	<λ/4@632,8
Coatings	AR(R<0,15%)@1064 nm on both sides
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns
Mount	Unmounted

Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES						
Material	σ_{gsa}[1)]@1,064 µm	σ_{esa}[2)]@1,064 µm	τ_{sa}[3)]	Laser crystal	λ_{laser}	σ_{gsa}/σ_{em}[4)]
$Cr^{4+}:Y_3Al_5O_{12}$	46×10^{-19} cm²	$8,2 \times 10^{-19}$ cm²	3,4 µs	Nd:YAG	0,946 µm	130
				Nd:YAG	1,06 µm	17
				Nd:GSAG	1,06 µm	55
				$Nd:YVO_4$	1,06 µm	3,5
				$Nd:GdVO_4$	1,06 µm	5
				$Nd:LuVO_4$	1,06 µm	3,4
				Nd:LSB	1,06 µm	40
				Nd:YAP	1,08 µm	14
				Yb:NLM	1,01 µm	500
				$Yb:YVO_4$	1,02 µm	625
				Yb:GGG	1,025 µm	250
				Yb:YAG	1,03 µm	250
				Yb:LuAG	1,03 µm	185
				Yb:KGW	1,035 µm	185

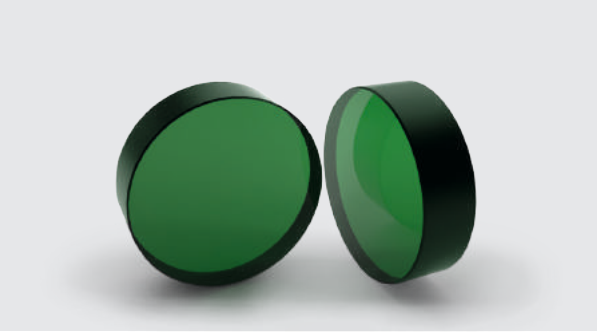
Crystal structure	Cubic
Density	4,56 g/cm³
Thermal expansion coefficient	$6,14 \times 10^{-6}$ K^{-1}
Thermal conductivity	11,2 Wm^{-1}K^{-1}
Mohs hardness	8,2
Refractive index	1,82@1064 nm

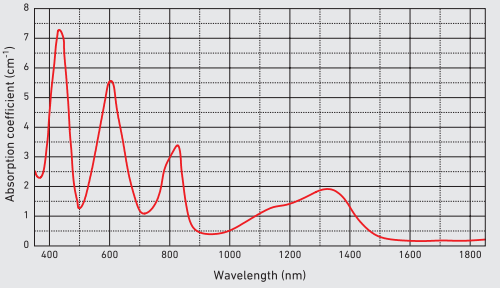
Herewith:
σ_{gsa}[1)] – ground-state absorption cross-section
σ_{esa}[2)] – excited-state absorption cross-section
τ_{sa}[3)] – recovery time
σ_{em}[4)] – emission cross-section

Standard products

FACE DIMENSIONS	INITIAL TRANSMISSION	COATINGS	SKU	PRICE
ø3 mm	20%@1064 nm	AR/AR@1064 nm	7279	195 €
	30%@1064 nm	AR/AR@1064 nm	7280	195 €
	40%@1064 nm	AR/AR@1064 nm	7281	195 €
	50%@1064 nm	AR/AR@1064 nm	7282	195 €
	60%@1064 nm	AR/AR@1064 nm	7283	195 €
	70%@1064 nm	AR/AR@1064 nm	7284	195 €
	80%@1064 nm	AR/AR@1064 nm	7285	195 €
	85%@1064 nm	AR/AR@1064 nm	7286	195 €
	90%@1064 nm	AR/AR@1064 nm	7287	195 €
	95%@1064 nm	AR/AR@1064 nm	7288	195 €
	98%@1064 nm	AR/AR@1064 nm	7289	195 €
ø6 mm	20%@1064 nm	AR/AR@1064 nm	7301	225 €
	30%@1064 nm	AR/AR@1064 nm	7302	225 €
	40%@1064 nm	AR/AR@1064 nm	7303	225 €
	50%@1064 nm	AR/AR@1064 nm	7304	225 €
	60%@1064 nm	AR/AR@1064 nm	7305	225 €
	70%@1064 nm	AR/AR@1064 nm	7306	225 €
	80%@1064 nm	AR/AR@1064 nm	7307	225 €
	85%@1064 nm	AR/AR@1064 nm	7308	225 €
	90%@1064 nm	AR/AR@1064 nm	7309	225 €
	95%@1064 nm	AR/AR@1064 nm	7310	225 €
	98%@1064 nm	AR/AR@1064 nm	7311	225 €
3 x 3 mm	20%@1064 nm	AR/AR@1064 nm	7290	195 €
	30%@1064 nm	AR/AR@1064 nm	7291	195 €
	40%@1064 nm	AR/AR@1064 nm	7292	195 €
	50%@1064 nm	AR/AR@1064 nm	7293	195 €
	60%@1064 nm	AR/AR@1064 nm	7294	195 €
	70%@1064 nm	AR/AR@1064 nm	7295	195 €
	80%@1064 nm	AR/AR@1064 nm	7296	195 €
	85%@1064 nm	AR/AR@1064 nm	7297	195 €
	90%@1064 nm	AR/AR@1064 nm	7298	195 €
	95%@1064 nm	AR/AR@1064 nm	7299	195 €
	98%@1064 nm	AR/AR@1064 nm	7300	195 €

V:YAG crystals





V:YAG is a relatively new saturable absorber. Passive Q-switch operation is available in the spectral range from 1064 nm to 1440 nm, primarily because of an extremely high ground state. These crystals can be used with active laser media such as Nd:YAG, Nd:YAP, Nd:KGW, Nd:YVO_4 and provide good lasing characteristics in passive Q-switched lasers. V:YAG features excellent optical, mechanical, and thermal properties and can be grown by Czochralski method.

Main features

- High ground state absorption
- Insignificant excited state absorption
- High contrast of the Q-switch
- Good optical, mechanical, and thermal properties
- UV-resistant and features a high damage threshold
- Custom crystals available upon request

Application examples

- Passively Q-switched lasers for laser rangefinders, LIDAR, and LIBS systems

Standard specifications

V:YAG CRYSTALS	
Initial transmission T_0	30-98%@1340 nm
Initial transmission T_0 tolerance	±1% (for values larger than 80%)
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	<λ/4@632,8
Coatings	AR(R<0,2%)@1310-1360 nm on both sides
Laser induced damage threshold	>10 J/cm²@1340 nm, 10 ns
Mount	Unmounted

Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES						
Material	σ_{gsa}[1]@1,34 µm	σ_{esa}[2]@1,34 µm	τ_{sa}[3]	Laser crystal	λ_{laser}	σ_{gsa}/σ_{em}[4]
$V^{3+}:Y_3Al_5O_{12}$	72 × 10^{-19} cm^2	7,4 × 10^{-19} cm^2	5-37 ns	Pr:YAP	0,747 µm	10
				$Ti:Al_2O_3$	0,78 µm	25
				Cr:LiCAF	0,78 µm	80
				Nd:GGG	0,93 µm	-
				Nd:YLF	1,05 µm	15
				Nd:YAG	1,06 µm	8
				$Nd:YVO_4$	1,06 µm	1,5
				Yb:KYW	1,035 µm	70
				Nd:YAP	1,34 µm	24
				$Nd:GdVO_4$	1,34 µm	30
				Er:glass	1,54 µm	45

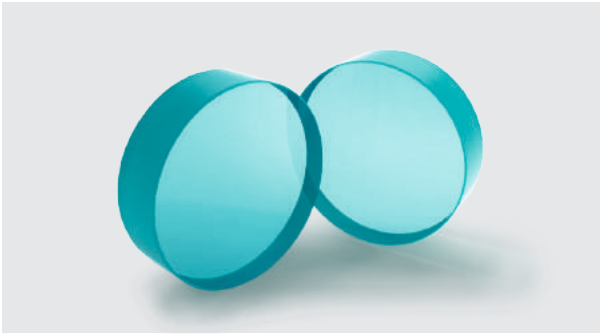
Crystal structure	Cubic
Density	4,56 g/cm^3
Thermal expansion coefficient	6,14 × 10^{-6} K^{-1}
Thermal conductivity	11,2 $Wm^{-1}K^{-1}$
Mohs hardness	8,2
Refractive index	1,82@1064 nm

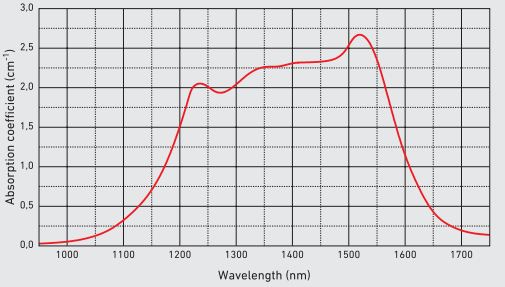
Herewith:
σ_{gsa}[1] – ground-state absorption cross-section
σ_{esa}[2] – excited-state absorption cross-section
τ_{sa}[3] – recovery time
σ_{em}[4] – emission cross-section

Standard products

FACE DIMENSIONS	INITIAL TRANSMISSION	COATINGS	SKU	PRICE
ø5 mm	30%@1340 nm	AR/AR@1310-1360 nm	7321	540 €
	40%@1340 nm	AR/AR@1310-1360 nm	7322	540 €
	50%@1340 nm	AR/AR@1310-1360 nm	7323	540 €
	60%@1340 nm	AR/AR@1310-1360 nm	7324	540 €
	70%@1340 nm	AR/AR@1310-1360 nm	7325	540 €
	80%@1340 nm	AR/AR@1310-1360 nm	7326	540 €
	85%@1340 nm	AR/AR@1310-1360 nm	7327	540 €
	90%@1340 nm	AR/AR@1310-1360 nm	7328	540 €
	95%@1340 nm	AR/AR@1310-1360 nm	7329	540 €
3 x 3 mm	30%@1340 nm	AR/AR@1310-1360 nm	7312	540 €
	40%@1340 nm	AR/AR@1310-1360 nm	7313	540 €
	50%@1340 nm	AR/AR@1310-1360 nm	7314	540 €
	60%@1340 nm	AR/AR@1310-1360 nm	7315	540 €
	70%@1340 nm	AR/AR@1310-1360 nm	7316	540 €
	80%@1340 nm	AR/AR@1310-1360 nm	7317	540 €
	85%@1340 nm	AR/AR@1310-1360 nm	7318	540 €
	90%@1340 nm	AR/AR@1310-1360 nm	7319	540 €
	95%@1340 nm	AR/AR@1310-1360 nm	7320	540 €

Co:Spinel crystals





Co:Spinel is a recently developed material, which has been proven to be a very effective passive Q-switch in lasers emitting in the range of 1,2 µm - 1,6 µm. Co:Spinel has a high absorption cross-section, which permits Q-switch operation of Er:glass laser (both flash-lamp and diode-laser pumped) without an intracavity focusing. Negligible excited-state absorption results in a high contrast Q-switch operation, the ratio of initial (small signal) to saturated absorption is higher than 10.

Main features

- Low optical losses in the wavelength range of 1,3 µm - 1,6 µm
- High laser induced damage threshold
- Custom crystals available upon request

Application examples

- Passive Q-switch for Er:Glass lasers @1,54 µm

Standard specifications

CO:SPINEL CRYSTALS	
Available initial T_0 transmission	50-99 %@1535 nm
Initial transmission T_0 tolerance	±1% (for values larger than 80%)
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	<λ/4@632,8 nm
Coatings	AR(R<0,15%)@1535 nm
Laser induced damage threshold	>8 J/cm²@1535 nm, 10 ns
Mount	Unmounted

Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES						
Material	σ_{gsa} [1]@1,54 µm	σ_{esa} [2]@1,54 µm	τ_{sa} [3]	Laser crystal	λ_{laser}	σ_{gsa}/σ_{em} [4]
$Co^{2+}:MgAl_2O_4$	$3,5 \times 10^{-19}$ cm²	$0,1 \times 10^{-19}$ cm²	220-350 ns	Nd:YAP	1,34 µm	1,5
				Nd:KGW	1,35 µm	4
				Nd:YAG	1,44 µm	12
				Er:glass	1,54 µm	40

Crystal structure	Cubic
Density	3,58 g/cm³
Thermal expansion coefficient	$6,14 \times 10^{-6}$ K^{-1}
Thermal conductivity	17 Wm^{-1}K^{-1}
Mohs hardness	8
Refractive index	1,6-1,75

Herewith:
σ_{gsa} [1] – ground-state absorption cross-section
σ_{esa} [2] – excited-state absorption cross-section
τ_{sa} [3] – recovery time
σ_{em} [4] – emission cross-section

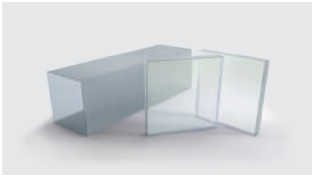
Standard products

FACE DIMENSIONS	INITIAL TRANSMISSION	COATINGS	SKU	PRICE
3 x 3 mm	80%@1535 nm	AR/AR@1535 nm	7331	340 €
	85%@1535 nm	AR/AR@1535 nm	7332	340 €
	90%@1535 nm	AR/AR@1535 nm	7333	340 €
	92%@1535 nm	AR/AR@1535 nm	7334	340 €
	95%@1535 nm	AR/AR@1535 nm	7335	340 €
	97%@1535 nm	AR/AR@1535 nm	7336	340 €
5 x 5 mm	80%@1535 nm	AR/AR@1535 nm	7338	390 €
	85%@1535 nm	AR/AR@1535 nm	7339	390 €
	90%@1535 nm	AR/AR@1535 nm	7340	390 €
	92%@1535 nm	AR/AR@1535 nm	7341	390 €
	95%@1535 nm	AR/AR@1535 nm	7342	390 €
	97%@1535 nm	AR/AR@1535 nm	7343	390 €

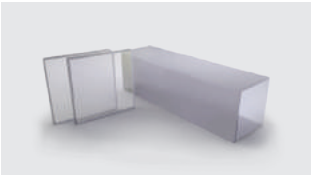
Nonlinear crystals

Nonlinear optical crystals are used in many different nonlinear parametric applications. To mention a few: second harmonic generation, difference frequency generation, optical parametric amplification and others. A proper crystal has to be chosen in order to use it for a particular application. It should have transparency in the required spectral range, adequate birefringence for phase-matching, a high nonlinear coefficient, high optical damage threshold, and other properties. Contact 4Lasers team for assistance and custom solutions.

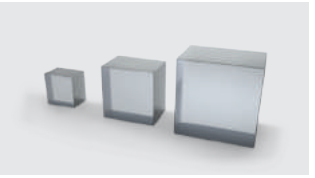
4Lasers develops and supplies different nonlinear crystals for fundamental, applied research and industrial applications. Available crystal growth techniques: Stepanov, Kyropoulos, Czochralski (CZ), temperature gradient technique (TGT), flux method.



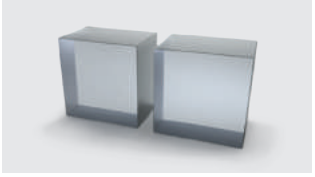
BBO crystals



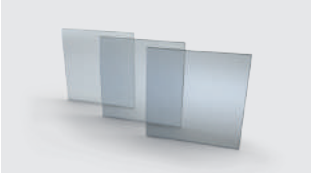
LBO crystals



KTP crystals

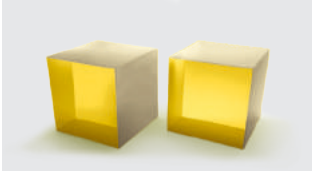


KDP, DKDP crystals



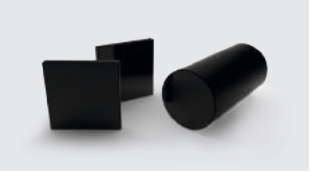
Lithium niobate crystals

$AgGaSe_2$ crystals



$AgGaS_2$ crystals

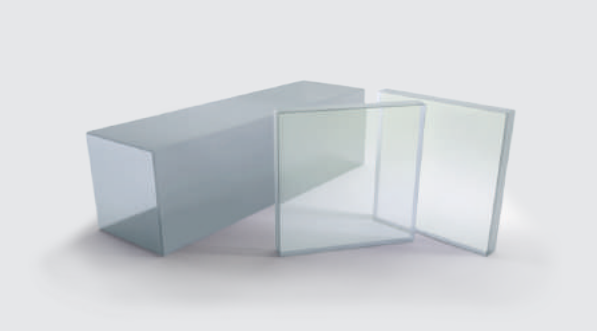
$ZnGeP_2$ crystals



CdSe crystals

GaSe crystals

BBO crystals



BBO crystal transparency ranges from 188 nm to 5,2 µm, which includes reasonable transparency from 3 µm - 5,2 µm for few tens µm thick crystals, while their phase-matchable range spans almost over the entire transparency range. Combined with other magnificent properties of BBO, it is favorable for numerous nonlinear parametric applications, e.g. harmonic generation of pulsed Yb-doped crystal based lasers and frequency doubling, tripling of Ti:Sapphire lasers, widely tunable type I and II OPO. It is worth to mention that BBO crystals have the highest nonlinearity in the UV range out of all common nonlinear crystals.

Main features

- Broad transparency ranges from 188 nm to 5,2 µm (reasonable transparency @3 µm - 5,2 µm for few tens µm thick crystals)
- Broad phase-matchable range for various second order nonlinear interactions over almost the entire transparency range
- Wide thermal acceptance bandwidth
- Highest nonlinearity of all UV nonlinear crystals
- High laser induced damage threshold
- Ultrathin crystals available for few optical cycle laser pulses
- Custom size, orientation and coatings are available upon request

Application examples

- Harmonic generation (up to fifth) of pulsed Nd-doped crystal based lasers
- Frequency doubling, tripling of pulsed Ti:Sapphire, Yb-doped, dye lasers
- Widely tunable type I and II OPO
- Characterization of ultrashort laser pulses by FROG, XFROG, SPIDER, dispersion scan, chirp scan methods

Standard specifications

BBO CRYSTALS	
Orientation accuracy	<30 arcmin
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<5 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Wavefront distortion	<λ/8@632,8 nm
Coatings	Low dispersion protective coatings or antireflective coatings on both sides
Laser induced damage threshold	>500 MW/cm^2@1064 nm, 10 ns
UVFS support	Crystals with <0,1 mm thickness are optically contacted to 0,5-1 mm UVFS support
Mount	Mounted in ø25,4 mm black or natural aluminum mount

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	β-BaB_2O_4
Crystal structure	Rhombohedral, 3m
Lattice parameters	a=12,532 Å, c=12,717 Å
Optical symmetry	Negative uniaxial (n_o>n_e)
Density	3,85 g/cm^3
Mohs hardness	4-4,5
Transparency range	188 nm – 5,2 μm, reasonable from 3 μm to 5,2 μm for thin crystals (few tens of μm)
Sellmeier equations @188 nm - 5,2 μm range (λ in μm)	$n_o^2 = 1 + 0{,}90291\ \lambda^2/(\lambda^2 - 0{,}003926) + 0{,}83155\ \lambda^2/(\lambda^2 - 0{,}018786) + 0{,}76536\ \lambda^2/(\lambda^2 - 60{,}01)$; $n_e^2 = 1 + 1{,}151075\ \lambda^2/(\lambda^2 - 0{,}007142) + 0{,}21803\ \lambda^2/(\lambda^2 - 0{,}02259) + 0{,}656\ \lambda^2/(\lambda^2 - 263)$
Refractive indices	n_o = 1,6551, n_e = 1,5426 @1064 nm

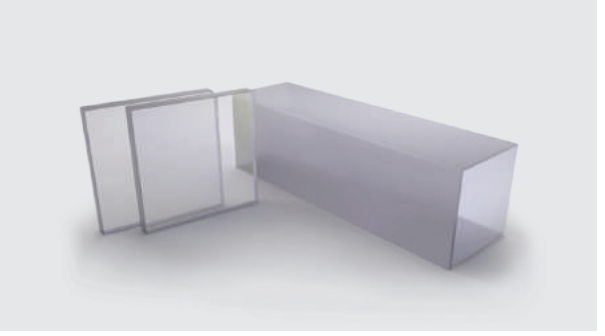
Guidance

4Lasers provide guidance and theoretical calculations for particular BBO applications. Contact us and we will help you to configure your crystal.

Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU	PRICE
6 x 6 mm	0,1 mm	50°	90°	P/P@515/257 nm	SHG@515 nm, 50 fs, type I	15808	500 €
	0,15 mm	50°	90°	P/P@515/257 nm	SHG@515 nm, 100 fs, type I	15809	480 €
	0,3 mm	50°	90°	P/P@515/257 nm	SHG@515 nm, 200 fs, type I	15810	450 €
	0,05 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 10 fs, type I	15811	620 €
	0,1 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 20 fs, type I	6399	450€
	0,2 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 50 fs, type I	15833	430 €
	0,5 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 100 fs, type I	6398	390 €
	1 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 200 fs, type I	6400	350 €
	0,5 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 50 fs, type I	9447	440 €
	1 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 100 fs, type I	9448	400 €
	1,5 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 150 fs, type I	9449	410 €
	2 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 200 fs, type I	10733	410 €
	0,01 mm	44,3°	90°	P/P@400-800 nm	THG@800 nm, 10 fs, type I	15834	800 €
	0,02 mm	44,3°	90°	P/P@400-800 nm	THG@800 nm, 20 fs, type I	15835	780 €
	0,05 mm	44,3°	90°	P/P@400-800 nm	THG@800 nm, 50 fs, type I	15836	700 €
	0,1 mm	44,3°	90°	P/P@400-800/266 nm	THG@800 nm, 100 fs, type I	9044	450 €
	0,2 mm	44,3°	90°	P/P@400-800/266 nm	THG@800 nm, 200 fs, type I	15837	450 €
	0,15 mm	32,5°	90°	AR/AR@515+1030/343 nm	THG@1030 nm, 50 fs, type I	9450	630 €
	0,25 mm	32,5°	90°	AR/AR@515+1030/343 nm	THG@1030 nm, 100 fs, type I	9451	580 €
	0,55 mm	32,5°	90°	AR/AR@515+1030/343 nm	THG@1030 nm, 200 fs, type I	9452	470 €

LBO crystals



Lithium Triborate (LiB_3O_5, LBO) crystals feature a broad transparency range, wide acceptance angle, small walk-off angle and the highest damage threshold among common nonlinear crystals. Most common applications include high-power near-infrared wavelength second harmonic generation, sum frequency generation to produce visible, ultraviolet laser light and visible, near-infrared widely tuned optical parametric oscillators. 4Lasers are capable of providing uncoated super-polished LBO crystals desired, e.g. for high-power UV generation via sum-frequency generation of 1064 nm and 532 nm.

Main features

- Broad transparency range from 155 nm to 3200 nm
- Absence of photochromic damage (gray-tracking)
- Highest damage threshold among common nonlinear crystals
- Small walk-off angle at room temperature, no walk-off at NCPM regime
- Wide acceptance angle
- Temperature tunable type I and II non-critical phase-matching
- Super-polished and custom crystals available upon request

Application examples

- Sum-frequency generation of 532 nm and 1064 nm to produce 355 nm UV radiation
- Widely tunable OPOs in NIR range pumped by second harmonic of Nd-doped lasers
- Efficient second harmonic generation at 1064 nm without walk-off effect (NCPM, t = 149 °C)

Standard specifications

LBO CRYSTALS	
Orientation accuracy	<30 arcmin
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Wavefront distortion	<λ/4@632,8 nm
Coatings	AR coatings on both sides
Laser induced damage threshold	>1 GW/cm²@1064 nm, 10 ns
Mount	Unmounted

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	LiB_3O_5
Crystal structure	Orthorhombic, mm^2
Lattice parameters	a = 8,46 Å, b = 7,38 Å , c = 12,717 Å
Optical symmetry	Negative biaxial ($2V_z$ = 109,2° @0,5321 µm)
Density	2,474 g/cm^3
Mohs hardness	6-7
Transparency range	155 nm - 3,2 µm @"0" transmittance level
Sellmeier equations @T = 293 K (**λ** in µm)	$n_X^2 = 2{,}4542 + 0{,}01125/(\lambda^2 - 0{,}01135) - 0{,}01388\,\lambda^2$; $n_Y^2 = 2{,}5390 + 0{,}01277/(\lambda^2 - 0{,}01189) - 0{,}01849\,\lambda^2 + 4{,}3025\times10^{-5}\lambda^4 - 2{,}9131\times10^{-5}\lambda^6$; $n_Z^2 = 2{,}5865 + 0{,}0131/(\lambda^2 - 0{,}01223) - 0{,}01862\,\lambda^2 + 4{,}5778\times10^{-5}\lambda^4 - 3{,}2526\times10^{-5}\lambda^6$
Refractive indices	n_X = 1,5656; n_Y = 1,5905; n_Z = 1,6055 @1064 nm

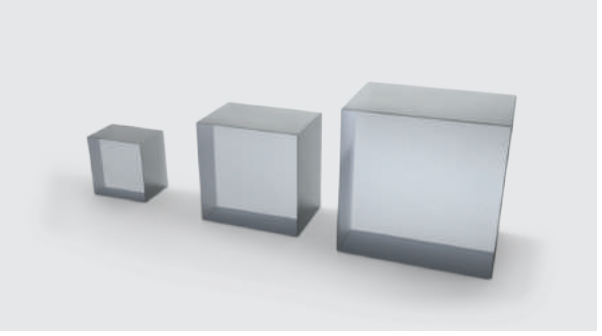
Guidance

4Lasers provides guidance and theoretical calculations for particular LBO applications. Contact us and we will help you to configure your crystal.

Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU	PRICE
3 x 3 mm	10 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7203	220 €
	10 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	7199	230 €
	10 mm	90°	0°	AR/AR@532+1064 nm	NCPM SHG@1064 nm, T = 149 °C	7209	220 €
	20 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7202	360 €
	20 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	9457	380 €
	20 mm	90°	0°	AR/AR@532+1064 nm	NCPM SHG@1064 nm, T = 149 °C	7210	360 €
5 x 5 mm	10 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7207	580 €
	10 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	7204	610 €
	20 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7208	850 €
	20 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	9459	900 €
6 x 6 mm	1 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9458	430 €
	2 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9460	400 €
	3 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9461	450 €
	4 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9462	500 €

KTP crystals



Potassium titanyl phosphate ($KTiOPO_4$, KTP) crystals are advantageous due to their high nonlinearity, great mechanical stability, high optical quality and transparency range of 350 nm - 4,5 µm. These features determine the wide application of KTP crystals as a nonlinear medium. It is an excellent solution for frequency doubling applications of Nd-doped lasers, especially for low and medium power applications, both intra- and extra-cavity design.
Besides, these crystals can be used as a nonlinear OPO medium for IR generation up to 4 µm and used as a pump source for mid-IR nonlinear crystal based optical parametric oscillators, such as ZGP OPO. KTP is susceptible to photochromic damage (grey-tracking), which causes deterioration of nonlinear conversion efficiency. 4Lasers provide high grey track resistance (HGTR) KTP crystals as a solution, which significantly improves the grey-track resistance and overall performance. HGTR KTP crystals extend the use of KTP as a nonlinear medium to high-power applications.
Please request in case you need HGTR KTP crystals for your applications.

Main features

- High nonlinearity
- Nonhygroscopic crystal
- Great mechanical stability
- Wide transparency range from 350 nm to 4,5 µm
- Broad angular and thermal acceptance
- Broad type I and II non-critical phase-matching range

Application examples

- Low and medium power frequency doubling of Nd-doped lasers
- KTP OPO and ZGP OPO tandem for mid-infrared generation

Standard specifications

KTP CRYSTALS	
Orientation accuracy	<30 arcmin
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<5 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Wavefront distortion	<λ/8@632,8 nm
Coatings	AR(R<0,25%)532+1064 nm on both faces
Laser induced damage threshold	>500 MW/cm^2@1064 nm, 10 ns
Mount	Unmounted

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$KTiOPO_4$
Crystal structure	Orthorhombic, mm^2
Lattice parameters	a = 12,814 Å, b = 6,404 Å, c = 10,616 Å
Optical symmetry	Positive biaxial ($2V_z$ = 37,4° @0,5461 µm)
Density	2,945 g/cm^3
Mohs hardness	5
Transparency range	350 nm - 4,5 µm @"0" transmittance level
Sellmeier equations (**λ** in µm)	$n_x^2 = 3{,}0067 + 0{,}0395/(\lambda^2 - 0{,}04251) - 0{,}01247\,\lambda^2$; $n_y^2 = 3{,}0319 + 0{,}04152/(\lambda^2 - 0{,}04586) - 0{,}01337\,\lambda^2$; $n_z^2 = 3{,}3134 + 0{,}05694/(\lambda^2 - 0{,}05941) - 0{,}016713\,\lambda^2$
Refractive indices	n_x = 1,7404; n_y = 1,7479; n_z = 1,8296 @1064 nm

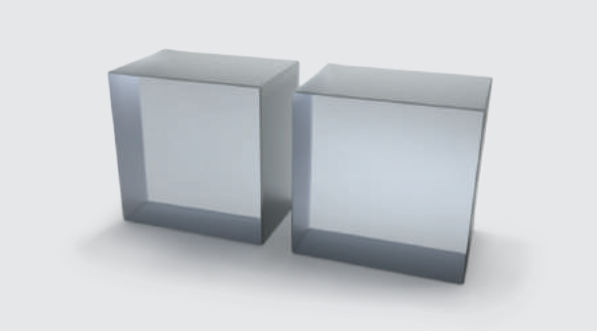
Guidance

4Lasers provide guidance and theoretical calculations for particular KTP applications. Contact us and we will help you to configure your crystal.

Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATING	APPLICATION	SKU	PRICE
3 x 3 mm	5 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7184	75 €
	10 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7188	105 €
5 x 5 mm	5 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7189	180 €
	10 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7193	290 €
7 x 7 mm	5 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7194	350 €
	10 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7198	495 €

KDP, DKDP crystals



Potassium dihydrogen phosphate (KH_2PO_4, KDP) and potassium dideuterium phosphate (KD_2PO_4, DKDP) crystals are one of the oldest used nonlinear materials. DKDP and KDP are known as analogs, though their properties differ due to DKDP deuteration. They both exhibit excellent ultraviolet transmission and high damage threshold. The nonlinearity of these crystals is relatively low, these crystals can be grown in large size.

They found their application as nonlinear frequency doublers, triplers and quandruplers of Nd-doped lasers and as Q-switch devices for Ti:Sapphire, Alexandrite, Nd-doped lasers. Main drawback is that these crystals are highly hygroscopic, therefore sealed housing and dry operating conditions have to be ensured.

Main features

- Excellent ultraviolet radiation transmission
- High laser induced damage threshold
- Custom crystals available upon request

Application exalmples

- Frequency doublers, triplers and quadruplers for Nd-doped lasers
- Q-switches for Ti:Sapphire, Alexandrite, Nd-doped lasers

Standard specifications

KDP AND DKDP CRYSTALS	
Orientation accuracy	<30 arcmin
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<5 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/4@632,8 nm
Coatings	AR coatings on both sides
Laser induced damage threshold	>10 J/cm²@1064 nm, 10 ns for KDP crystals >5 J/cm²@1064 nm, 10 ns for DKDP
Mount	Unmounted

Properties

PHYSICAL AND OPTICAL PROPERTIES		
Chemical formula	KH_2PO_4 (KDP)	KD_2PO_4 (DKDP)
Crystal structure	Tetragonal, 42m	Tetragonal, 42m
Lattice parameters	a = 7,448 Å, c = 6,977 Å	a = 7,4697 Å, c = 6,966 Å
Optical symmetry	Negative uniaxial ($n_o > n_e$)	Negative uniaxial ($n_o > n_e$)
Density	2,332 g/cm^3	2,355 g/cm^3
Mohs hardness	2,5	2,5
Transparency range	180 nm - 1,5 µm	200 nm - 2 µm
Refractive indices	n_o = 1,4938, n_e = 1,4599 @1,06 µm	n_o = 1,4931; n_e = 1,4582 @1,06 µm

KDP Sellmeier equations @T = 293 k (λ in µm)	$n_o^2 = 2{,}259276 + 13{,}00522\,\lambda^2/(\lambda^2 - 400) + 0{,}01008956/(\lambda^2 - (77{,}26408)^{-1})$; $n_e^2 = 2{,}132668 + 3{,}2279924\,\lambda^2/(\lambda^2 - 400) + 0{,}008637494/(\lambda^2 - (81{,}42631)^2)$
DKDP Sellmeier equations @T = 293 K (λ in µm)	$n_o^2 = 2{,}240921 + 2{,}246956\,\lambda^2/(\lambda^2 - (11{,}26591)^2) + 0{,}009676/(\lambda^2 - (0{,}124981)^2)$; $n_e^2 = 2{,}126019 + 0{,}784404\,\lambda^2/(\lambda^2 - (11{,}10871)^2) + 0{,}008578/(\lambda^2 - (0{,}109505)^2)$

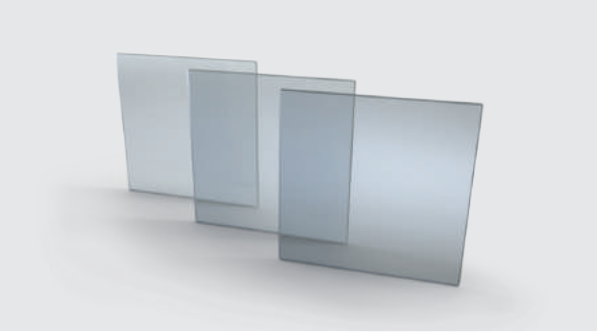
Guidance

4Lasers provide guidance and theoretical calculations for particular KDP and DKDP applications. Contact us and we will help you to configure your crystal.

Standard products

MATERIAL	FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU	PRICE
KDP	12 x 12 mm	5 mm	76,5°	45°	AR/AR@532/266 nm	SHG@532 nm, type I	9421	450 €
	15 x 15 mm	7 mm	76,5°	45°	AR/AR@532/266 nm	SHG@532 nm, type I	9422	480 €
DKDP	12 x 12 mm	20 mm	53,5°	0°	AR/AR@1064/532+1064 nm	SHG@1064 nm, type II	9426	750 €
	12 x 12 mm	20 mm	59,3°	0°	AR/AR@1064/532+1064 nm	THG@1064 nm, type II	9425	750 €
	15 x 15 mm	13 mm	36,5°	45°	AR/AR@532+1064 nm	SHG@1064 nm, type I	9423	800 €
	15 x 15 mm	13 mm	53,5°	0°	AR/AR@532+1064 nm	SHG@1064 nm, type II	9424	800 €
	15 x 15 mm	20 mm	53,5°	0°	AR/AR@1064/532+1064 nm	SHG@1064 nm, type II	9427	870 €
	15 x 15 mm	20 mm	59,3°	0°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	9428	870 €

Lithium niobate crystals



Lithium niobate ($LiNbO_3$, LN) is a multi-purpose material in photonics and optoelectronics fields. It features a wide transparency range from 420 nm to 5,2 µm, excellent nonlinear, electro-optic, and piezoelectric properties. Most common applications include infrared range optical modulation and Q-switching, nonlinear frequency conversion of >1 µm wavelengths. Their electrical and optical properties can be adjusted using magnesium or zirconium dopants.

Main features

- Broad transparency region from 420 nm to 5200 nm
- High nonlinear, electro-optic and acousto-optic coefficients
- Nonhygroscopic, mechanically, and chemically stable

Application examples

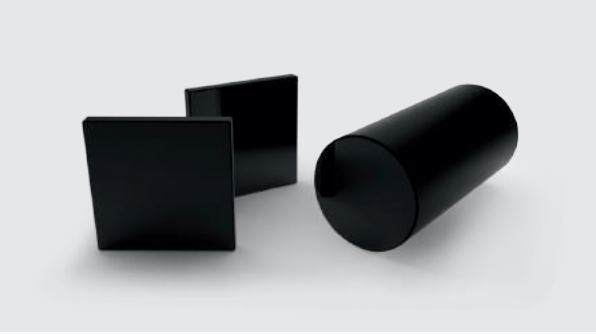
- Electro-optic modulation and Q-switching
- Optical parametric oscillators (OPO) pumped at 1064 nm
- Quasi-phase-matched devices with periodically poled lithium niobate (PPLN)

4Lasers does not provide standard product list. Please contact us for solutions and pricing.

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$LiNbO_3$
Crystal structure	Trigonal, 3m
Optical symmetry	Negative uniaxial ($n_o > n_e$)
Density	4,64 g/cm^3
Mohs hardness	5
Transparency range	420 nm - 5,2 µm
Sellmeier equations (λ in µm)	$n_o^2 = 4{,}9048 + 0{,}11768/(\lambda^2 - 0{,}04750) - 0{,}027169\ \lambda^2$; $n_e^2 = 4{,}5820 + 0{,}099169/(\lambda^2 - 0{,}04443) - 0{,}021950\ \lambda^2$
Refractive indices	$n_o = 2{,}220$; $n_e = 2{,}146$ @1064 nm

CdSe crystals



Cadmium selenide (CdSe) crystals feature an infrared transmission up to 24 μm, reasonably large nonlinearity and small walk-off angle. CdSe crystals can be employed into difference frequency generation (DFG), optical parametric oscillation (OPO) schemes to generate infrared laser radiation above ZGP absorption edge (>12 μm). For instance, CdSe OPO can potentially be pumped by 2 μm Tm-doped, Ho-doped, Tm and Ho co-doped lasers and produce far infrared idler radiation. Besides nonlinear optic applications cadmium selenide crystal material can be used for IR optical elements: substrates, polarizers, waveplates, etc.

Main features

- Wide transparency range (0,7-24 μm)
- Reasonably large nonlinearity
- Small walk-off angle

Application examples

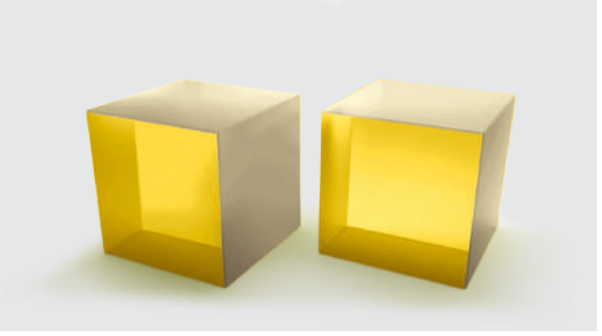
- Far infrared wavelength radiation generation by DFG, OPO schemes
- Material for infrared optical elements: substrates, polarizers, waveplates, etc.

4Lasers does not provide standard product list. Please contact us for solutions and pricing.

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	CdSe
Crystal structure	Hexagonal, 6mm
Lattice parameters	a = 4,2985 Å, c = 7,0150 Å
Optical symmetry	Positive uniaxial ($n_e > n_o$)
Density@288 K	5,81 g/cm^3
Mohs hardness	3,25
Transparency range	0,7-24 μm @"0" transmittance level)
Dispersion equations @T = 293 K (λ in μm)	$n_o^2 = 4{,}2243 + 1{,}7680\ \lambda^2/(\lambda^2 - 0{,}2270) + 3{,}1200\ \lambda^2/(\lambda^2 - 3380)$; $n_e^2 = 4{,}2009 + 1{,}8875\ \lambda^2/(\lambda^2 - 0{,}2171) + 3{,}6461\ \lambda^2/(\lambda^2 - 3629)$
Refractive indices	n_o = 2,431, n_e = 2,452@10,0 μm
Thermal conductivity @T = 293 K	6,9 (∥c) Wm^{-1}K^{-1}, 6,2 (⊥c) Wm-1K^{-1}
Laser induced damage threshold	60 MW/cm^2@10,6 μm, 200 ns

$AgGaS_2$ crystals



Silver Thiogallate ($AgGaS_2$, AGS) has been demonstrated as an efficient crystal for nonlinear parametric interactions in the infrared spectral range. Its transparency region ranges from 0,53 to 12 µm. AGS based optical parametric oscillators feature continuously tunable radiation over a wide range of wavelengths in the infrared spectral range. High transparency in the short wavelength range beginning at 550 nm is used in OPOs pumped by Nd:YAG laser.

Using 2050 nm pump laser, an optimally designed $AgGaS_2$ OPO is tunable from about 2.5 to 12.0 µm. The output range can be extended by the sum or difference frequency mixing (SFM/DFM). This crystal features a high non-linear coefficient, high damage threshold, and a wide transmission range. It also exhibits a low optical absorption and scattering, low wavefront distortion. $AgGaS_2$ has the highest figure of merit for non-linear interactions in the near and deep infrared.

Main features

- Unique non-linear properties across the transmission range from 0,5 to 12 µm
- Low optical absorption and scattering
- Transparency at short wavelengths

Application examples

- Frequency mixing in the middle IR region from 4,0 to 18,3 µm
- Second harmonic generation and up-conversion for CO_2 lasers
- Tunable OPO for solid-state lasers

Standard specifications

$AgGaS_2$ CRYSTALS	
Orientation accuracy	<30 arcmin
Clear aperture	>80%
Face dimensions tolerance	+0,0/-0,2 mm
Parallelism error	<30 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,2 mm at 45°
Surface quality	60-40 S-D
Coatings	BBAR/BBAR@1,2-2,6 µm/2,6-11 µm
Mount	Unmounted

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$AgGaS_2$
Crystal structure	Tetragonal, 42m
Lattice parameters	a = 5,742 Å, c = 10,26 Å
Optical symmetry	Negative uniaxial ($n_o > n_e$, λ<0,497 µm $n_e > n_o$)
Density	4,58 g/cm^3
Mohs hardness	3-3,5
Transparency range	0,47 - 13 µm @"0" transmittance level
Sellmeier equations @T = 293 K (λ in µm)	$n_o^2 = 5{,}79419 + 0{,}23114/(\lambda^2 - 0{,}06882) - 2{,}4534 \times 10^{-3}\lambda^2 + 3{,}1814 \times 10^{-7}\lambda^4 - 9{,}7051 \times 10^{-9}\lambda^6$; $n_e^2 = 5{,}54120 + 0{,}22041/(\lambda^2 - 0{,}09824) - 2{,}5240 \times 10^{-3}\lambda^2 + 3{,}6214 \times 10^{-7}\lambda^4 - 8{,}3605 \times 10^{-9}\lambda^6$
Refractive indices	n_o = 2,3471; n_e = 2,2914 @ 10,6321 µm
Thermal conductivity	1,4 (||c) Wm^{-1}K^{-1}, 1,5 (⊥c) Wm^{-1}K^{-1}

Guidance

4Lasers provides guidance and theoretical calculations for particular $AgGaS_2$ applications. Contact us and we will help you to configure your crystal.

Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU	PRICE
5 x 5 mm	1 mm	39°	45°	BBAR/BBAR@1,2-2,6/2,6-11 µm	DFG@1,2-2,6 µm, type I	7356	Request
8 x 8 mm	1 mm	39°	45°	BBAR/BBAR@1,2-2,6/2,6-11 µm	DFG@1,2-2,6 µm, type I	7395	Request
6 x 6 mm	2 mm	50°	0°	BBAR/BBAR@1,2-2,6/2,6-11 µm	DFG@1,2-2,6 µm, type II	7396	Request
8 x 8 mm	2 mm	50°	0°	BBAR/BBAR@1,2-2,6/2,6-11 µm	DFG@1,2-2,6 µm, type II	7397	Request

$AgGaSe_2$ crystals

Silver gallium selenide ($AgGaSe_2$, AGSe) is an optically negative uniaxial crystal with a reasonable transmittance over roughly 0,7 µm - 18 µm region. AGSe crystals have proven to be used in nonlinear parametric downconversion (difference frequency generation, DGF) in the Mid-IR range by tandem with commercially available synchronously-pumped optical parametric oscillators (SPOPOs) in the femtosecond and picosecond regime [1]. AGSe crystal has one of the highest figure of merits (~70 pm^2/V^2) from commercially available mid-IR nonlinear crystals, which is six times larger than counterpart AGS. For some particular reasons AGSe is also a better choice over other mid-IR crystals. For example, even though GaSe has higher nonlinearity and comparable transparency region, AGSe has lower spatial walk-off and availability to be processed for particular application (growth and cut direction, dielectric thin-film coatings). ZGP has higher figure of merit, but its transparency region (~2-12 µm) is no match to AGSe.

Main features

- Excellent properties across the transmission range from 0,73 to 18 µm
- Low optical absorption and scattering
- High FOM (figure of merit) for non-linear interactions in NIR and MIR

Application examples

- Frequency mixing in the IR region from 4,0 to 18,3 µm
- Second harmonic generation and up-conversion for CO_2 lasers
- Tunable OPO for solid-state lasers with efficiency up to 10%

Standard specifications

$AgGaSe_2$ CRYSTALS	
Orientation accuracy	<30 arcmin
Clear aperture	>80%
Face dimensions tolerance	+0,0/-0,2 mm
Parallelism error	<30 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,2 mm at 45°
Surface quality	60-40 S-D
Coatings	BBAR/BBAR@1,7-2,7 µm/5-18 µm
Mount	Unmounted

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$AgGaSe_2$
Crystal structure	Tetragonal, 42m
Lattice parameters	a = 5,9920 Å, c = 10,8803 Å
Optical symmetry	Negative uniaxial ($n_o > n_e$, $\lambda < 804$ nm, $n_e > n_o$)
Density	5,7 g/cm^3
Mohs hardness	3-3,5
Transparency range	0,71 - 19 µm @"0" transmittance level
Sellmeier equations @T=293 K (λ in µm)	$n_o^2 = 6{,}8507 + 0{,}4297/(\lambda^2 - 0{,}1584) - 0{,}00125\,\lambda^2$; $n_e^2 = 6{,}6792 + 0{,}4598/(\lambda^2 - 0{,}2122) - 0{,}00126\,\lambda^2$
Refractive indices	n_o = 2,5917; n_e = 2,5585 @10,5 µm
Thermal conductivity @T = 293 K	1 (||c) Wm^{-1}K^{-1}, 1,1 (⊥c) Wm^{-1}K^{-1}
Laser induced damage threshold	>10 MW/cm^2@10,6 µm, 150 ns

Guidance

4Lasers provides guidance and theoretical calculations for particular $AgGaSe_2$ applications. Contact us and we will help you to configure your crystal.

Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU	PRICE
5 x 5 mm	2 mm	52°	45°	BBAR@1,7-2,7 µm/BBAR@5-18 µm	Ultrashort pulse DFG@1,7-2,7 µm -> ~5-18 µm, type I	15806	Request
	5 mm	52°	45°	BBAR@1,7-2,7 µm/BBAR@5-18 µm	Ultrashort pulse DFG@1,7-2,7 µm -> ~5-18 µm, type I	15807	Request
	10 mm	52°	45°	BBAR@1,7-2,7 µm/BBAR@5-18 µm	Ultrashort pulse DFG@1,7-2,7 µm -> ~5-18 µm, type I	15805	Request

$ZnGeP_2$ crystals

Zinc-germanium diphosphide ($ZnGeP_2$, ZGP) crystals are considered as state-of-the-art mid-IR nonlinear crystals due to unique properties. They exhibit an excellent nonlinearity and thermal conductivity (36 W/mK@||c, 35 W/mK@⊥c) together with a relatively high laser induced damage threshold. ZGP crystal can be successfully implemented in high-power mid-IR harmonic generators, difference frequency generators and optical parametric oscillators due its broad useful transmission range (2-12 µm).

Main features

- Useful transmission range from 2 µm to 12 µm
- High nonlinearity
- Relatively high damage threshold
- Nominal absorption coefficient <0,04 cm^{-1} at ~2,1 µm for o-wave

Application examples

- Harmonic generation of CO_2 and CO laser fundamental wavelength
- Generation of continuously tunable radiation in MWIR, LWIR range by OPO and DFG techniques
- Generation of terahertz range frequencies

Standard specifications

$ZnGeP_2$ CRYSTALS	
Orientation accuracy	<30 arcmin
Clear aperture	>80%
Face dimensions tolerance	+0,0/-0,2 mm
Length tolerance	+1,0/-0,0 mm
Parallelism error	<30 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,2 mm at 45°
Surface quality	60-40 S-D
Surface flatness	λ/4@632,8 nm
Coatings	Antireflective coatings @2,1 µm + 3,5-5 µm on both sides
Nominal absorption coefficient	≤0,04 cm^{-1}@2,1 µm, o-wave
Mount	Unmounted

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$ZnGeP_2$
Crystal structure	Tetragonal, 42m
Lattice parameters	a = 5,465 Å, c = 10,708 Å
Optical symmetry	Positive uniaxial ($n_e > n_o$)
Density	4,162 g/cm^3
Mohs hardness	5,5
Transparency range	0,74 - 12 µm @"0" transmittance level
Dispersion equations @1,5 - 10,59 µm range, T = 293 K (λ in µm)	$n_o^2 = 11{,}6413 + 0{,}69363/(\lambda^2 - 0{,}21967) + 1586{,}06/(\lambda^2 - 832{,}75)$; $n_e^2 = 12{,}1438 + 0{,}75255/(\lambda^2 - 0{,}21913) + 2061{,}68/(\lambda^2 - 951{,}07)$
Refractive indices	n_o = 3,0738; n_e = 3,1137 @10,5 µm
Thermal conductivity @T = 293 K	36 (∥c) Wm^{-1}K^{-1}, 35 (⊥c) Wm-1K^{-1}
Laser induced damage threshold	60 MW/cm^2@10,6 µm, 100 ns

Guidance

4Lasers provides guidance and theoretical calculations for particular $ZnGeP_2$ applications. Contact us and we will help you to configure your crystal.

Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU	PRICE
5 x 5 mm	10 mm	55,3°	0°	AR@2,1 µm + BBAR@3,5-5 µm	MWIR generation, type I, eeo interaction	15358	Request
	15 mm	55,3°	0°	AR@2,1 µm + BBAR@3,5-5 µm	MWIR generation, type I, eeo interaction	15359	Request
	20 mm	55,3°	0°	AR@2,1 µm + BBAR@3,5-5 µm	MWIR generation, type I, eeo interaction	15360	Request

GaSe crystals

4Lasers offer z-cut, cleaved surface and mounted gallium selenide (GaSe) crystals. Custom clear apertures and crystal thicknesses from tens of microns up to several millimeters are available upon request.

Due to fragile nature of GaSe it is not possible to apply antireflection coatings.

Main features

- Broad transparency range from 0,65 µm to 18 µm
- Large nonlinearity and birefringence
- Soft and cleaves along [001] plane
- Cannot be cut and polished at certain angles
- Comes uncoated and mounted for proper handling

Application examples

- Broadband mid-IR difference frequency generation
- Second harmonic (SH) of CO_2, CO, dye lasers
- Terahertz (THz) generation by optical rectification
- Terahertz detectors for terahertz time domain spectroscopy (THz-TDS)

Standard specifications

GaSe CRYSTALS	
Clear aperture	ø5 mm or custom
Surface quality	Cleaved surfaces
Coatings	Uncoated, unavailable
Mount	ø25,4 mm black anodized aluminum mount

Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	GaSe
Crystal structure	Hexagonal, -62m
Lattice parameters	A = 3,742 Å, c = 15,918 Å
Optical symmetry	Negative uniaxial (no>ne)
Density	5,03 g/cm^3
Mohs hardness	≈ 0
Transparency range	0,62-20 µm @ "0" transmittance level
Sellmeir equations	$n_o^2 = 7{,}443 + 0{,}4050/\lambda^2 + 0{,}0186/\lambda^4 + 0{,}0061/\lambda^6 + 3{,}1485\,\lambda^2/(\lambda^2 - 2194)$; $n_e^2 = 5{,}76 + 0{,}3879/\lambda^2 - 0{,}2288/\lambda^4 + 0{,}1223/\lambda^6 + 1{,}8550\,\lambda^2/(\lambda^2 - 1780)$
Refractive indices	n_o = 2,8158; n_e = 2,4392 @10,6 µm

Guidance

4Lasers provides guidance and theoretical calculations for particular GaSe applications. Contact us and we will help you to configure your crystal.

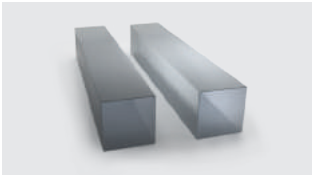
Standard products

CLEAR APERTURE	LENGTH	ORIENTATION	COATINGS	SKU	PRICE
ø5 mm	0,5 mm	z-cut	Uncoated	13185	1000 €
	1 mm	z-cut	Uncoated	11982	1125 €
	2 mm	z-cut	Uncoated	13183	1250 €

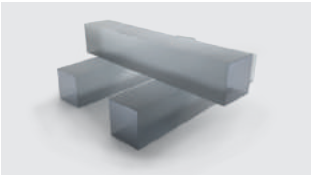
Raman crystals

Inelastic photon-phonon-interaction in Raman crystals gives rise to Stokes or anti-Stokes shift of pump radiation. It is the so-called Stimulated Raman scattering (SRS). This is a versatile method for frequency conversion, which does not need to be phase-matched, features a high conversion efficiency and is easily compatible with current solid-state lasers. Suchlike Raman generator emission lines can cover the wavelength range from UV to NIR due to cascaded SRS. For a selective Raman shift line amplification, the Raman crystal has to be placed into a resonator with an appropriate optical feedback.

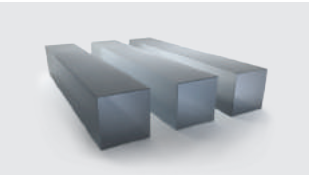
4Lasers provide barium nitrate and undoped KGW, KYW Raman crystals. Do not hesitate to request custom, if desired crystals are not present in the standard list.



Barium nitrate crystals

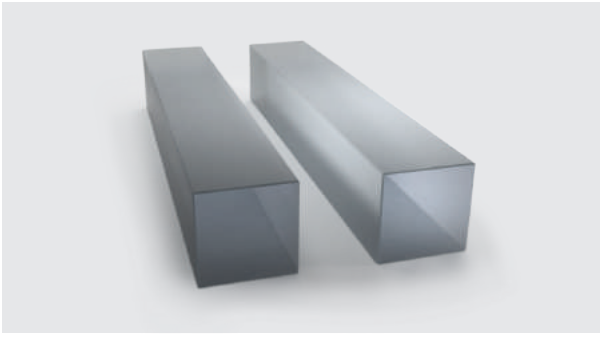


KGW crystals



KYW crystals

Barium nitrate crystals



Barium nitrate ($Ba(NO_3)_2$) is one of the leading crystals among solid-state Raman shifters in terms of Raman gain coefficient, which is known to be the highest at nanosecond steady-state regime (g_R = 47 cm/GW@532 nm pump). Barium nitrate also features a moderately broad transparency range (0,33 µm - 1,8 µm) and high damage threshold. Drawbacks of barium nitrate crystal are low thermal conductivity (1,17 $Wm^{-1}K^{-1}$) and high thermo-optic coefficient ($dn/dT = -20 \times 10^{-6}K^{-1}$), which lead to the thermal lensing effect. The crystal is soft and hygroscopic, therefore should be treated with caution. 4Lasers recommend using barium nitrate as a Raman shifter for nanosecond applications.

Main features

- Transparency range from 350 nm to 1800 nm
- Raman frequency shift of 1048 cm^{-1}
- Excellent Raman shifter for nanosecond applications
- Custom crystal dimensions and coatings available upon request

Application examples

- External cavity Raman laser pumped by commercially available passively Q-switched nanosecond Nd:YAG laser
- Generation of 1,59 µm "eye-safe" radiation, which coincides with CO_2 absorption line

Standard specifications

BARIUM NITRATE CRYSTALS	
Orientation	[110]
Clear aperture	>85%
Face dimensions tolerance	±0,5 mm
Length tolerance	±1 mm
Parallelism error	<5 arcmin
Perpendicularity error	<10 arcmin
Protective chamfers	<0,25 mm at 45°
Surface quality	40-20 S-D
Surface flatness	<λ /4@632,8 nm
Coatings	AR/AR@500-700 nm
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns
Mount	Unmounted

Properties

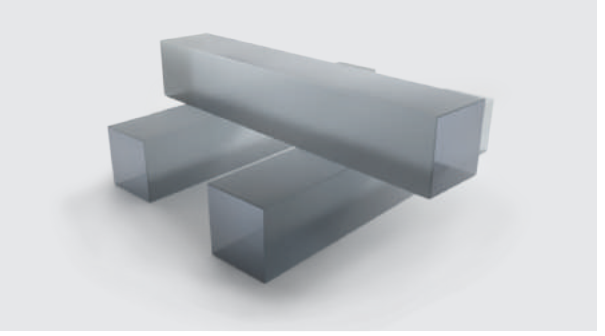
PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$Ba(NO_3)_2$
Crystal structure	Cubic, $P2_13$
Lattice parameters	a = b = c = 8,11 Å
Density	3,25 g/cm^3
Mohs hardness	2,5-3
Transparency range	0,33 µm - 1,8 µm
Refractive index	1,555@1064 nm
Thermal conductivity	1,17 $Wm^{-1}K^{-1}$@‖c
Thermal expansion coefficient	13×10^{-6} 1 $^oC^{-1}$
dn/dT	$-20\times10^{-6}K^{-1}$
Raman frequency shift	1047 cm^{-1}
Raman linewidth	0,4 cm^{-1}
Raman gain (ns, steady-state regime)	47 cm/GW@532 nm 11 cm/GW@1064 nm
Dephasing time	28 ps

Standard products

FACE DIMENSIONS	LENGTH	COATINGS	SKU	PRICE
5 x 5 mm	15 mm	AR/AR@500-700 nm	28479	790 €
	30 mm	AR/AR@500-700 nm	28480	950 €
	45 mm	AR/AR@500-700 nm	28481	1125 €
8 x 8 mm	75 mm	AR/AR@500-700 nm	28482	1280 €

Minimum order quantity: 2 pieces.

KGW crystals



Potassium gadolinium tungstate ($KGd(WO_4)_2$, KGW) crystals feature good mechanical properties, relatively good thermal conductivity (2,5-3,4 $Wm^{-1}K^{-1}$) and wide transparency range, which spans from 350 nm to 5 µm. KGW as a Raman crystal features two large Raman modes at 768 cm^{-1} and 901 cm^{-1}, which are pump polarization dependent. 4Lasers recommend using KGW crystal as a Raman shifter for picosecond applications.

Main features

- Broad transparency range from 300 nm to 5 µm
- Two pump polarization-dependent Raman shifts at 768 cm^{-1} and 901 cm^{-1}
- Excellent Raman shifter for picosecond applications
- Custom dimensions, orientation, and coatings available upon request

Application examples

- Raman generator pumped by commercially available picosecond Nd:YAG laser

Standard specifications

KGW CRYSTALS	
Orientation	b-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	<λ/4@632,8 nm
Coatings	AR(R<0,7%)@500-650 nm
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns
Mount	Unmounted

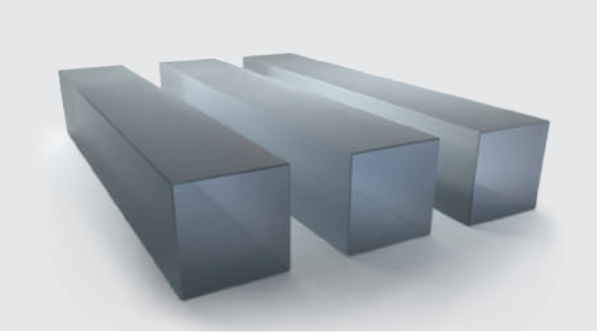
Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$KGd(WO_4)_2$
Crystal structure	Monoclinic, C2c
Lattice parameters	a = 10,652(4) Å, b = 10,374(6) Å, c = 7,582(2) Å
Density	7,27 g/cm^3
Mohs hardness	4-5
Transparency range	0,3 µm - 5 µm
Refractive indices@1064 nm	n_p = 1,982 n_m = 2,010 n_g = 2,061
Thermal conductivity	K_a = 2,6 Wm^{-1}K^{-1} K_b = 3,8 Wm^{-1}K^{-1} K_c = 3,4 Wm^{-1}K^{-1}
dn/dT	dn_p/dT = -15,7×10^{-6}K^{-1} dn_m/dT = -11,8×10^{-6}K^{-1} dn_g/dT = -17,3×10^{-6}K^{-1}
Raman frequency shift	901 cm^{-1} (p[mm]p), 767 cm^{-1} (p[gg]p)
Raman linewidth	5,4 cm^{-1}@901 cm^{-1} (p[mm]p) 6,4 cm^{-1}@767 cm^{-1} (p[gg]p)
Raman gain (ps, transient-state regime)	11 cm/GW@532 nm 3 cm/GW@1064 nm
Dephasing time	2 ps

Standard products

FACE DIMENSIONS	LENGTH	COATINGS	SKU	PRICE
5 x 5 mm	15 mm	Uncoated	7259	440 €
		AR/AR@450-800 nm	7262	600 €
	30 mm	Uncoated	7260	540 €
		AR/AR@450-800 nm	7263	710 €
	45 mm	Uncoated	7261	750 €
		AR/AR@450-800 nm	7264	930 €

KYW crystals



Potassium yttrium tungstate ($KY(WO_4)_2$, KYW) crystals offer two strong phonon modes around 765 cm^{-1} and 905 cm^{-1}, which have similar Raman gain and are pump polarization dependent. KYW crystals possess good mechanical properties, high optical damage threshold, broad transparency range (350 nm - 5,5 µm) and thermal conductivity around three times higher than barium nitrate.

Main features

- Broad transparency range from 350 nm to 5,5 µm
- Two large Raman shifts of 765 cm^{-1} and 905 cm^{-1}

Application examples

- Raman lasers
- Radiation frequency tuning

Standard specifications

KYW CRYSTALS	
Orientation	b-cut
Clear aperture	>90%
Face dimensions tolerance	+0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	<λ/4@632,8 nm
Coatings	AR(R<0,7%)@500-650 nm
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns
Mount	Unmounted

Properties

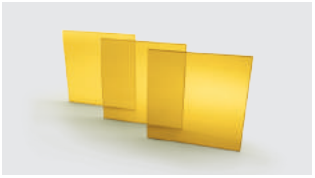
PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$KY(WO_4)_2$
Crystal structure	Monoclinic, C2/c
Lattice parameters	a = 10,64 Å, b = 10,32 Å, c = 7,55 Å
Density	6,61 g/cm^3
Mohs hardness	4-5
Transparency range	0,35-5,5 µm
Refractive indices (1064 nm, room temperature)	n_p = 1,9688 n_m = 2,0065 n_g = 2,0507
Thermal conductivity (average value)	3,3 Wm^{-1}K^{-1}
dn/dT	$dn_p/dT = -14{,}6\times10^{-6}$ K^{-1} $dn_m/dT = -8{,}9\times10^{-6}$ K^{-1} $dn_g/dT = -12{,}4\times10^{-6}$ K^{-1}
Raman frequency shift (T = 300 K)	905 cm^{-1} (E||N_m) 765 cm^{-1} (E||N_g)
Raman gain (1064 nm pump, steady-state regime)	3,6 cm/GW

Standard products

FACE DIMENSIONS	LENGTH	COATINGS	SKU	PRICE
5 x 5 mm	15 mm	Uncoated	7273	440 €
		AR/AR@450-800 nm	7276	600 €
	30 mm	Uncoated	7274	540 €
		AR/AR@450-800 nm	7277	710 €
	45 mm	Uncoated	7275	750 €
		AR/AR@450-800 nm	7278	930 €

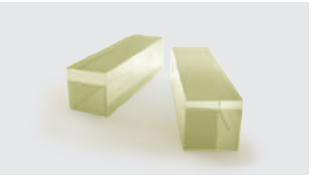
Photorefractive crystals

4Lasers provide BSO, Fe:LiNbO3, SBN and BGO crystals not mainly, but necessarily for applications, which exploit photorefractive effect. Photorefractive effect is a phenomenon whereby the local index of refraction is modified by spatial variations of light intensity. It is observed when coherent light interferes with each other in photorefractive material, which forms a spatially varying pattern of illumination. The effect can be used to store temporary, erasable holograms, also known as holographic data storage. It can also be used to create phase-conjugate mirrors or optical spatial solitons.



BSO crystals

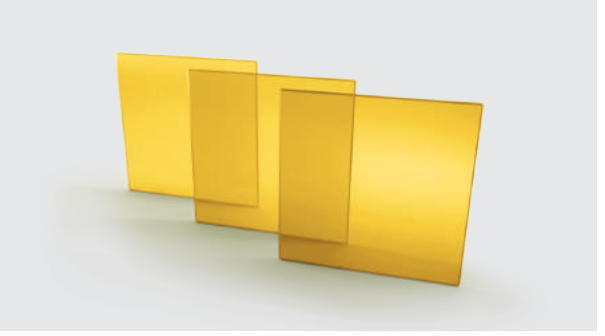
Fe:$LiNbO_3$ crystals



SBN crystals

BGO crystals

BSO crystals



Bismuth silicone oxide ($Bi_{12}SiO_{20}$, BSO) crystals are highly efficient photoconductors with a low dark conductivity, that allows a build-up of large photo-induced space-charges. Tremendous photoconductivity and electro-optic properties make BSO crystals attractive in a range of applications: spatial light modulators, optical switches, phase conjugation mixers. BSO crystals are grown by modified Czochralski method and available in up to 3" diameter aperture size. Crystals can be supplied with ITO coatings on request.

Main features

- High electro-optic coefficient (r_{41} = 5 pm/V)
- High phase-conjugation efficiency
- Available in large size elements or wafers up to 3"
- Customization available upon request

Application examples

- Spatial light modulators
- Optical switches
- Pockels readout optical memory (PROM) applications
- Optical waveguides

Standard specifications

BSO CRYSTALS	
Clear aperture	85%
Face dimensions tolerance	+0/-0,2 mm
Thickness tolerance	±0,2 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,3 mm at 45°
Surface quality	40-20 S-D
Wavefront distortion	<λ/4@632,8 nm
Coatings	Uncoated
Mount	Unmounted

Properties

MAIN PROPERTIES	
Chemical formula	$Bi_{12}SiO_{20}$
Crystal structure	Cubic, point group 23
Lattice parameters	10,10 Å
Density	9,2 g/cm^3
Mohs hardness	5
Transmission Range	0,45-6 µm
Refractive Index	2,54@0,63 µm
Optical Activity	42 deg/mm@500 nm
Electro-optic coefficient	r_{41} = 5 pm/V
Dielectric constant (low frequency)	56
Dark resistance	10^{14} Ohm cm

Standard products

FACE DIMENSIONS	LENGTH	ORIENTATION	SKU	PRICE
5 x 5 mm	5 mm	[100]	6885	Request
	5 mm	[110]	6884	Request
10 x 10 mm	5 mm	[100]	6883	Request
	5 mm	[110]	6882	Request
20 x 20 mm	1,0 mm	[100]	6881	490 €
	1,0 mm	[110]	6880	490 €
30 x 30 mm	1,0 mm	[110]	1558	620 €
	1,5 mm	[110]	9095	620 €

BGO crystals

Bismuth germanite ($Bi_{12}GeO_{20}$, BGO) crystals are highly efficient photoconductors with a low dark conductivity, that allows a build-up of large photo-induced space-charges. Tremendous photoconductivity and electro-optic properties make BSO crystals attractive in a range of applications: spatial light modulators, optical switches, phase conjugation mixers. BSO crystals are grown by modified Czochralski method and available in up to 3" diameter aperture size. Crystals can be supplied with ITO coatings on request.

Main features

- High electro-optic coefficient (r_{41} = 3,5 pm/V)
- Low dark conductivity
- Large size elements or wafers up to 3"
- Customization available upon request

Application examples

- Spatial light modulators
- Optical switches
- Optical correlators

Standard specifications

BGO CRYSTALS	
Clear aperture	85%
Face dimensions tolerance	+0/-0,2 mm
Thickness tolerance	±0,2 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,3 mm at 45°
Surface quality	40-20 S-D
Wavefront distortion	<λ/4@632,8 nm
Coatings	Uncoated
Mount	Unmounted

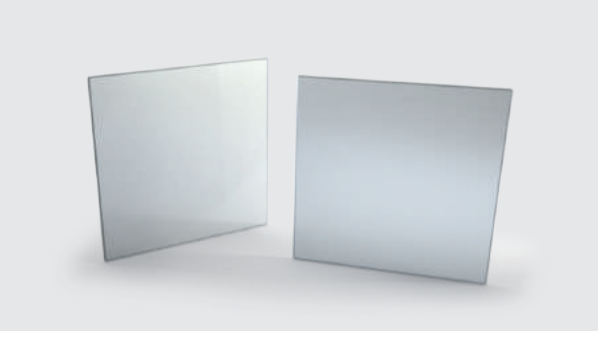
Properties

MAIN PROPERTIES	
Chemical formula	$Bi_{12}GeO_{20}$
Crystal structure	Cubic, point group 23
Lattice parameters	10,15 Å
Density	9,2 g/cm^3
Transmission Range	0,45-7 µm
Refractive Index @0.63µm	2,55
Optical Activity @500 nm	41,5 deg/mm
Electro-Optic Coefficient r_{41}	3,5 pm/V
Dielectric constant	40
Dark Resistance	10^{14} Ohm cm

Standard products

FACE DIMENSIONS	LENGTH	ORIENTATION	SKU	PRICE
5 x 5 mm	5 mm	[100]	6871	520 €
	5 mm	[110]	6868	520 €
10 x 10 mm	5 mm	[100]	6873	680 €
	5 mm	[110]	6872	680 €
20 x 20 mm	1 mm	[100]	6875	490 €
	1 mm	[110]	6874	490 €
30 x 30 mm	1 mm	[110]	6876	590 €
	1,5 mm	[110]	6877	590 €

Fe:$LiNbO_3$ crystals



Lithium niobate ($LiNbO_3$, LN) crystal doped with iron (Fe:$LiNbO_3$) is an attractive photorefractive material, due to the high photorefractive sensitivity, high electro-optic coefficients and diffraction efficiency, chemo-mechanical properties. Fe:$LiNbO_3$ crystals are grown by Czochralsky method and available in large size. Wide range of available dopants and levels enable to adjust material properties for particular applications. What is more, Fe:$LiNbO_3$ crystals are easy to handle, low cost, therefore suitable for volume production.

Main features

- High electro-optic coefficient (r_{41} = 5 pm/V)
- High phase conjugation efficiency
- Available in large size elements or wafers up to 3"
- Customization available upon request

Application examples

- Spatial light modulators
- Optical switches
- Holographic recording
- Optical waveguides

Standard specifications

FE:$LINBO_3$ CRYSTALS	
Dopant level, Fe_2O_3	0,02 mol. % 0,03 mol. % 0,05 mol. % 0,1 mol. %
Orientation	90° cut (X-cut, Y-cut)
Clear aperture	85%
Face dimensions tolerance	+0/-0,2 mm
Thickness tolerance	±0,2 mm
Parallelism error	<3 arcmin
Protective chamfers	<0,3 mm at 45°
Surface quality	20-10 S-D
Wavefront distortion	<λ/4@632,8 nm
Coatings	None, antireflective or indium tin oxide coatings available upon request
Electrodes	None, available upon request
Mount	Unmounted

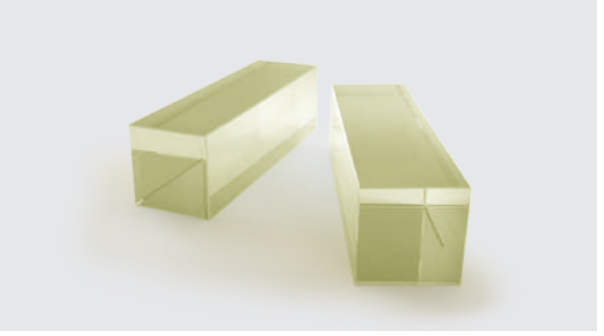
Properties

MAIN PROPERTIES	
Chemical formula	Fe:$LiNbO_3$
Crystal structure	Trigonal, 3m
Density	4,64 g/cm^3
Mohs hardness	5
Transmission range	0,35-5,5 µm
Refractive index @0.63 µm	n_e = 2,20 n_o = 2,29
Electro-optic coefficients	r_{22} = 6,8 pm/V r_{31} = 10 pm/V r_{33} = 32 pm/V
Dielectric constant	e_{11} = 85 e_{33} = 30

Standard products

FACE DIMENSIONS	LENGTH	DOPING	SKU	PRICE
10 x 10 mm	1 mm	0,02 % Fe_2O_3	7006	495 €
		0,03 % Fe_2O_3	7007	495 €
		0,05 % Fe_2O_3	7008	495 €
		0,1 % Fe_2O_3	7009	495 €
	5 mm	0,02 % Fe_2O_3	6457	Request
		0,03 % Fe_2O_3	6458	Request
		0,05 % Fe_2O_3	4052	Request
		0,1 % Fe_2O_3	7005	Request
20 x 20 mm	1 mm	0,02 % Fe_2O_3	7010	Request
		0,03 % Fe_2O_3	7011	Request
		0,05 % Fe_2O_3	7012	Request
		0,1 % Fe_2O_3	7013	Request

SBN crystals



Strontium-barium niobate ($Sr_xBa_{(1-x)}Nb_2O_6$, SBN:x, x = 61) crystals feature excellent optical and photorefractive properties. They are available nominally pure or doped with Ce. Different composition SBN crystals found their application in electro-optics, acousto-optics, photorefractive, non-linear optics fields. 4Lasers provide inclusion-free and homogenous SBN crystals, which are grown by Modified Stepanov method and available with linear dimensions up to 40 mm.

Main features

- Pure or doped with Ce
- Efficient phase-conjugation
- Custom size, doping level, unpoled, antireflective coated and electrodeless crystals are available upon request.

Application examples

- Optical information recording
- Pyroelectrical detectors
- Self-pumped self-conjugation mirror
- Optical correlators

Standard specifications

SBN:61 CRYSTALS	
Orientation	Short edge along tetragonal axis
Poling	Poled or unpoled
Electrodes	Carbon-water electrodes or no electrodes
Clear aperture	85%
Face dimensions tolerance	+0/-0,2 mm
Thickness tolerance	±0,2 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,1 mm at 45°
Surface quality	40-20 S-D over clear aperture, 60-40 S-D other surfaces
Surface flatness	<λ/4@632,8 nm
Coatings	Uncoated
Mount	Unmounted

Properties

MAIN PROPERTIES	
Composition	SBN:61
Crystal structure	Tetragonal, 4 mm
Lattice parameters	a = 12,46 Å, c = 3,946 Å
Density	5,4 g/cm^3
Mohs hardness	5,5
Melting temperature	1480°C
Curie temperature	75°C
Transparency range	0,45-5,5 µm
Refractive index @633 nm	n_o = 2,3103 n_e = 2,2817
Δn @633 nm	-0,0286
Half-wave voltage (λ/2)	240 V
Dielectric constant, (T = 293 K)	900
Electro-optic coefficients	r_{13} = 45 pm/V r_{33} = 250 pm/V
Pyroelectric coefficient	0,065 µC cm^{-2} K^{-1}
Dielectric constant	880

Standard products

MATERIAL	FACE DIMENSIONS	LENGTH	DOPING	SKU	PRICE
SBN:61	5 x 5 mm	5 mm	Undoped	73	1850 €
			CeO2 0,002 wt, %	6940	1850 €
			CeO2 0,01 wt, %	6944	1850 €
		10 mm	Undoped	74	2250 €
			CeO2 0,002 wt, %	6941	2250 €
			CeO2 0,01 wt, %	6945	2250 €
		15 mm	Undoped	75	2750 €
			CeO2 0,002 wt, %	6942	2750 €
			CeO2 0,01 wt, %	6946	2750 €
		20 mm	Undoped	76	3400 €
			CeO2 0,002 wt, %	6943	3400 €
			CeO2 0,01 wt, %	6947	3400 €

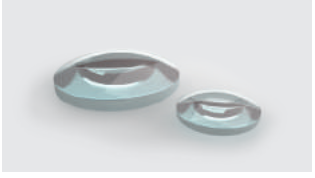
Laser components

Take a tour through a standard list of 4Lasers laser components, including dielectric thin-film mirrors, metal-coated mirrors, beamsplitters, lenses, prisms, windows, substrates, and filters for ultraviolet, visible and infrared applications. Do not hesitate to request custom, if particular components that you are looking for are not in the standard list.

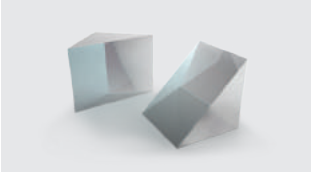
Coated laser components

Metal-coated mirrors

Beamsplitters



Lenses



Prisms

Windows and substrates

Filters

Coated laser components

4Lasers provides dielectric thin-film and metal-coated laser components for use in the ultraviolet, visible, and infrared wavelength ranges. Non-standard components are available upon request. Contact us for custom solutions and pricing.

4Lasers standard dielectric thin-film coated mirrors are designed for laser-line, broadband, multi-wavelength and beamsplitting or combining applications. Standard dielectric thin-film optical elements also include laser cavity output couplers and variable reflectivity mirrors, which are primarily used as output mirrors for stable and unstable laser resonators, respectively.

Metal-coated mirrors are an excellent choice for applications, where uniform, broadband, low GDD, nearly angle of incidence insensitive reflectance is required. 4Lasers provide standard flat and curved metal-coated mirrors with the following metal-coatings: UV enhanced aluminum, protected aluminum, protected silver, enhanced silver and protected gold.

Dielectric thin-film mirrors

Metal-coated mirrors

Beamsplitters

Laser line mirrors

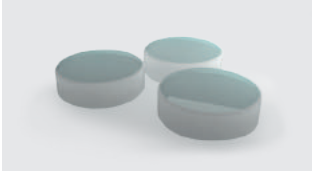
Broadband laser mirrors

Dual and multi-wavelength mirrors

Variable reflectivity mirrors

Laser cavity output couplers

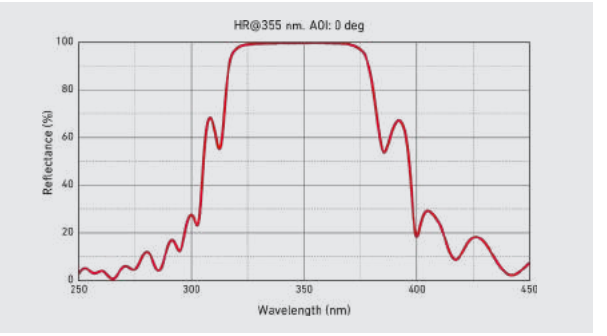
Low GDD ultrafast mirrors



Wavelength separators and combiners

Metal-coated mirrors

Laser line mirrors



Laser line mirrors exhibit high reflectance over a particular spectral range, extending <10% of the central wavelength, at a specific angle of incidence and polarization for non-normal incidence. Reflectance properties are based on the optical interference phenomena of reflections from multiple dielectric thin-film layers, which are carefully deposited on UV grade fused silica optical substrates.

Main features

- Mirror substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions are ø25,4 x 5 mm
- 0° or 45° angle of incidence selection
- Designed for a high reflectance over a certain spectral range and angle of incidence
- Custom coatings, substrate material and dimensions are available upon request

Application examples

- Nearly loss-free light beam steering and folding in laser-based systems

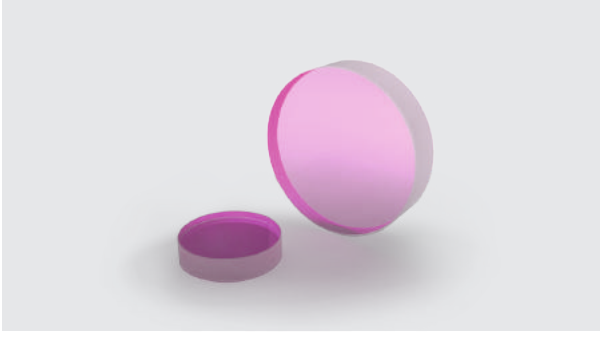
Standard specifications

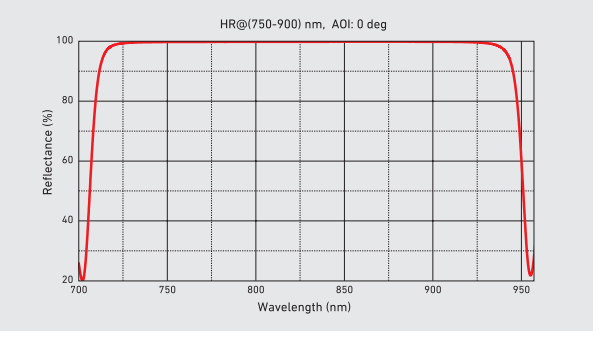
LASER LINE MIRRORS	
Substrate material	UV grade fused silica
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Laser induced damage threshold	>12 J/cm²@1064 nm, 10 ns (for 1020-1070 nm mirrors)

Standard products

MATERIAL	DIMENSIONS	WAVELENGTH RANGE	REFLECTANCE	AOI	SKU	PRICE
UVFS	ø25,4 x 5 mm	254-266 nm	>99,3%	0°	6375	75 €
	ø25,4 x 5 mm	340-355 nm	>99,5%	0°	6376	60 €
	ø25,4 x 5 mm	340-355 nm	>99,85%	0°	9280	110 €
	ø25,4 x 5 mm	385-415 nm	>99,5%	0°	6377	60 €
	ø25,4 x 5 mm	510-535 nm	>99,5%	0°	6378	60 €
	ø25,4 x 5 mm	510-535 nm	>99,9%	0°	9281	90 €
	ø25,4 x 5 mm	770-830 nm	>99,5%	0°	6379	60 €
	ø25,4 x 5 mm	1020-1070 nm	>99,5%	0°	6386	60 €
	ø25,4 x 5 mm	1020-1070 nm	>99,95%	0°	9282	110 €
	ø25,4 x 5 mm	1520-1570 nm	>99,5%	0°	6380	75 €
	ø25,4 x 5 mm	1890-1990 nm	>99,5%	0°	6381	85 €
	ø25,4 x 5 mm	2000-2100 nm	>99,5%	0°	6382	95 €
	ø25,4 x 5 mm	254-266 nm	Rs>99,5%, Rp>98,5%	45°	6383	75 €
	ø25,4 x 5 mm	340-355 nm	Rs>99,6%, Rp>99,2%	45°	6384	60 €
	ø25,4 x 5 mm	340-355 nm	Rs>99,85%, Rp>99,7%	45°	9283	120 €
	ø25,4 x 6,35 mm	510-532 nm	Rs>99,6%, Rp>99,0%	0-45°	15207	86 €
	ø25,4 x 5 mm	510-535 nm	Rs>99,6%, Rp>99,2%	45°	6385	60 €
	ø25,4 x 5 mm	510-535 nm	Rs>99,95%, Rp>99,85%	45°	9284	95 €
	ø25,4 x 5 mm	385-415 nm	Rs>99,6%, Rp>99,2%	45°	6387	60 €
	ø25,4 x 5 mm	770-830 nm	Rs>99,6%, Rp>99,2%	45°	6388	60 €
	ø25,4 x 6,35 mm	1020-1070 nm	Rs>99,6%, Rp>99,0%	0-45°	15208	86 €
	ø25,4 x 5 mm	1020-1070 nm	Rs>99,6%, Rp>99,2%	45°	6389	60 €
	ø25,4 x 5 mm	1020-1070 nm	Rs>99,95%, Rp>99,85%	45°	9285	120 €
	ø25,4 x 5 mm	1520-1570 nm	Rs>99,6%, Rp>99,2%	45°	6390	75 €
	ø25,4 x 5 mm	1890-1990 nm	Rs>99,6%, Rp>99,2%	45°	6392	85 €
	ø25,4 x 5 mm	2000-2100 nm	Rs>99,6%, Rp>99,2%	45°	6391	95 €

Broadband laser mirrors





Broadband laser mirrors provide high average reflectance over a broad spectral range at a specific angle of incidence and polarization for non-normal incidence. These properties are based on the optical interference phenomena of reflections from multiple dielectric thin-film layers, which are carefully deposited on UV grade fused silica optical substrates.

Main features

- Mirror substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions are ø25,4 x 5 mm
- Designed for a high reflectance (>99%) over a broad wavelength range
- 0° or 45° angle of incidence selection
- Custom coatings, substrate material and dimensions are available upon request

Application examples

- High reflectivity mirrors for tunable and broadband laser sources
- Broadband light beam steering and folding

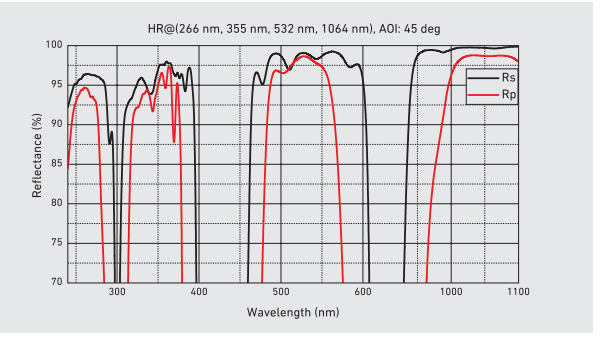
Standard specifications

BROADBAND LASER MIRRORS	
Substrate material	UV grade fused silica
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Laser induced damage threshold	1 J/cm^2@1064 nm, 10 ns (for 750-1100 nm mirrors)

Standard products

MATERIAL	DIMENSIONS	WAVELENGTH RANGE	AVERAGE REFLECTANCE	AOI	SKU	PRICE
UVFS	ø25,4 x 5 mm	350-400 nm	>99%	0°	6289	60 €
		400-700 nm	>99%	0°	6290	85 €
		750-1100 nm	>99%	0°	6323	85 €
		1280-1600 nm	>99%	0°	6326	105 €
		350-400 nm	>99% (s+p)/2	45°	6327	60 €
		400-700 nm	>99% (s+p)/2	45°	6324	85 €
		750-1100 nm	>99% (s+p)/2	45°	6328	85 €
		1280-1600 nm	>99% (s+p)/2	45°	6325	105 €

Dual and multi wavelength mirrors



Dual ant multi wavelength mirrors provide a high reflectance over several certain spectral ranges at a specific angle of incidence and polarization for non-normal incidence. Reflectance properties are based on the optical interference phenomena of reflections from multiple dielectric thin-film layers, which are carefully deposited on UV grade fused silica optical substrates.

Main features

- Mirror substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions are ø25,4 x 5 mm
- Designed to be highly reflective at several certain wavelength ranges
- 0° or 45° angle of incidence selection
- Custom coatings, substrate material and dimensions are available upon request

Application examples

- Simultaneous beam steering and folding of fundamental radiation laser beam and its harmonics
- Laser system alignment using visible wavelength laser

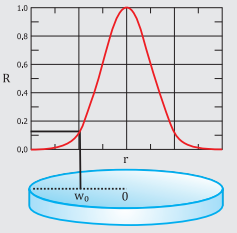
Standard specifications

DUAL AND MULTI WAVELENGTH MIRRORS	
Substrate material	UV grade fused silica
Substrate dimensions	ø25,4 x 5 mm
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Laser induced damage threshold	4 J/cm²@1064 nm, 10 ns (for 510-535 nm + 1020-1070 nm mirrors)

Standard products

MATERIAL	DIMENSIONS	WAVELENGTH RANGE	REFLECTANCE	AOI	SKU	PRICE
UVFS	ø25,4 x 5 mm	254-266 nm + 510-535 nm	>99%	0°	6330	105 €
		385-415 nm + 770-830 nm	>99,5%	0°	6331	85 €
		510-535 nm + 1020-1070 nm	>99,5%	0°	6332	85 €
		254-266 nm + 340-355 nm + 510-535 nm + 1020-1070 nm	>97%	0°	6329	145 €
		254-266 nm + 510-535 nm	Rs>99%, Rp>98%	45°	6334	105 €
		385-415 nm + 770-830 nm	Rs>99,5%, Rp>98,5%	45°	6335	85 €
		510-535 nm + 1020-1070 nm	Rs>99,5%, Rp>98,5%	45°	6336	85 €
		254-266 nm + 340-355 nm + 510-535 nm + 1020-1070 nm	Rs>97%, Rp>94%	45°	6333	145 €

Variable reflectivity mirrors



Function of reflection:

$$R = R_0 \times \exp\left[-2\left(\frac{r}{w_0}\right)^n\right]$$

Herewith:

R_0 - peak reflectance
r - radial coordinate
w_0 - radius at R_0/e^2 level
n - Gaussian order

4Lasers variable reflectivity mirrors provide a circularly symmetric reflectance profile according to the super-Gaussian function with order of 2. These mirrors are favorable in high-power unstable laser resonators for their wide filling of the active medium and weak diffraction on hard-edge aperture. Therefore, super-Gaussian variable reflectivity mirrors contribute to better near- and far-field beam quality. It is worth to mention that variable reflectivity mirrors can be designed to have various reflectance profiles, such as linear, parabolic, Gaussian.

Main features

- Mirror substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions are ø25,4 x 5 mm
- Central reflectance from 15% to 35% at 1064 nm wavelength
- Custom reflectance profiles, substrates material and dimensions are available upon request

Application examples

- Laser cavity output coupler for unstable laser resonator

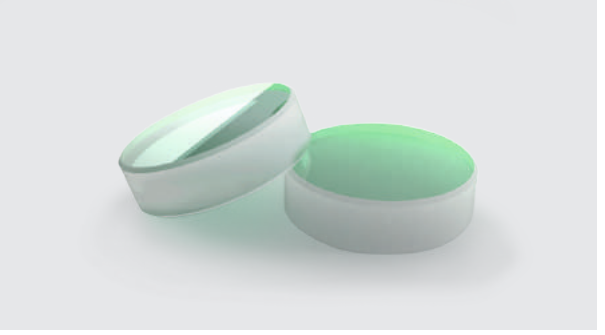
Standard specifications

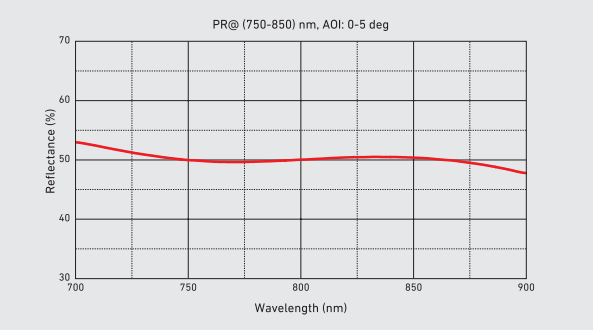
VARIABLE REFLECTIVITY MIRRORS	
Radius w_0	2 mm
Gaussian order n	2
Substrate material	UV grade fused silica
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Rear surface	Antireflective coated
Laser induced damage threshold	>6 J/cm²@1064 nm, 10 ns

Standard products

MATERIAL	DIMENSIONS	WAVELENGTH	CENTRAL REFLECTANCE	SKU	PRICE
UVFS	ø25,4 x 5 mm	1064 nm	15%	6539	Request
			20%	6540	Request
			25%	6541	Request
			30%	6542	Request
			35%	6543	Request

Laser cavity output couplers





Output couplers are used in stable laser resonators in order to emit a part of the energy, which is circulating in the laser cavity. One has to carefully select the proper spatially constant reflection/transmission ratio of the output coupler in order to optimize the lasing operation and prevent from damaging intracavity optical elements. Front surface of output couplers is partially reflective coated at a certain wavelength range, while the rear surface is antireflective coated in order to prevent Fresnel reflection losses. What is more, these laser cavity output couplers can be successfully implemented as fixed ratio laser power attenuators for a certain wavelength range.

Main features

- Mirror substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions ø25,4 x 5 mm
- 50% - 99% reflectance selection at most popular wavelength ranges
- Custom coatings, substrate material and dimensions available upon request

Application examples

- Output couplers for stable laser resonators
- Partial reflectors (beam attenuators)

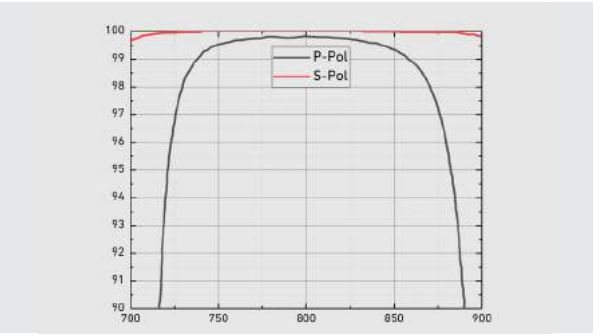
Standard specifications

LASER CAVITY OUTPUT COUPLERS	
Substrate material	UV grade fused silica
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Rear side	Antireflective coated at operating wavelength range
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns (for 1020-1070 nm couplers)

Standard products

MATERIAL	DIMENSIONS	WAVELENGTH RANGE	REFLECTANCE	AOI	SKU	PRICE
UVFS	ø25,4 x 5 mm	770-830 nm	50% ± 3%	0-5°	6522	95 €
			75% ± 3%	0-5°	6523	95 €
			90% ± 3%	0-5°	6524	95 €
			95% ± 2%	0-5°	6525	95 €
			97% ± 1%	0-5°	6444	95 €
			99% ± 0,5%	0-5°	6526	95 €
		1020-1070 nm	50% ± 3%	0-5°	6527	95 €
			75% ± 3%	0-5°	6528	95 €
			90% ± 3%	0-5°	6529	95 €
			95% ± 2%	0-5°	6530	95 €
			97% ± 1%	0-5°	6531	95 €
			99% ± 0,5%	0-5°	6532	95 €
		1520-1570 nm	50% ± 3%	0-5°	6533	115 €
			75% ± 3%	0-5°	6534	115 €
			90% ± 3%	0-5°	6535	115 €
			95% ± 2%	0-5°	6536	115 €
			97% ± 1%	0-5°	6537	115 €
			99% ± 0,5%	0-5°	6538	115 €

Low GDD ultrafast mirrors



Low GDD Ultrafast mirrors are designed for high power ultrashort (femtosecond) laser pulse applications to provide both maximized high reflectivity and minimized low GDD value at the same time. Such coatings are used for internal and external beam manipulation applications where pulse broadening effect is undesirable.

Our Low GDD Ultrafast mirrors are intended for Ti:Sapphire, Nd:Glass or Ytterbium doped host based lasers working in femtosecond regimes.

Main features

- Mirror substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions are ⌀25,4 x 5 mm
- Coating stack is designed to have low dispersion (GDD) for the reflected wavelengths
- 0° or 45° angle of incidence selection
- Custom coatings, substrate material and dimensions are available upon request

Application examples

- High reflectivity mirrors for tunable and broadband ultrashort laser sources
- Broadband light beam steering and folding

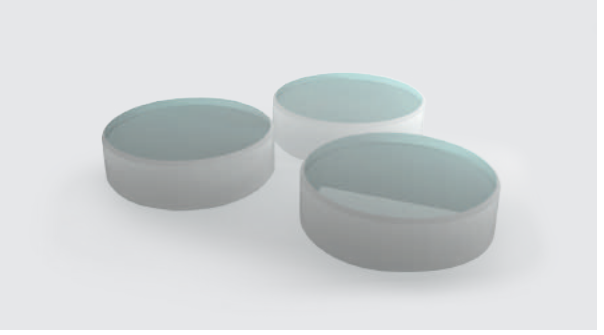
Standard specifications

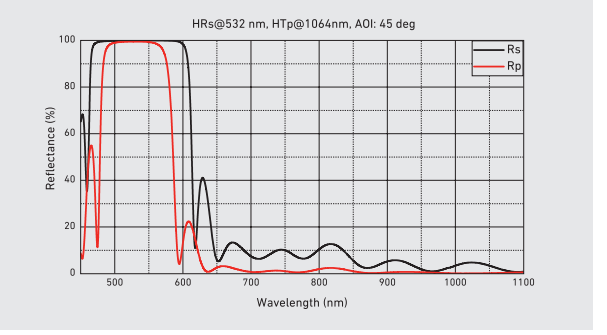
LOW GDD ULTRAFAST MIRRORS	
Substrate material	UV grade fused silica
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Laser induced damage threshold	>2 J/cm²@800 nm, 200 ns (for 730-870 nm mirrors)

Standard products

MATERIAL	GROUP DELAY DISPERSION	CLEAR APERTURE	THICKNESS TOLERANCE	SURFACE QUALITY	FACE DIMENSIONS	PROTECTIVE CHAMFERS	THICKNESS	COATING S1	SKU	PRICE
UVFS	<100 fs2 @ 750-850nm	90%	±0,2 mm	20-10 S-D	⌀50,8 mm	<0,5 mm at 45°	6,35 mm	HR(Rs>99,5%@710-890 nm; Rp>98,5%@740-860 nm)	18689	145 €
								HR(R>99,5%)@730-870 nm	18796	145 €
					⌀25,4 mm	<0,25 mm at 45°	5 mm	HR(R>99,5%)@730-870 nm	28437	76 €
								HR(Rs>99,5%@710-890 nm; Rp>98,5%@740-860 nm)	9531	76 €

Wavelength separators and combiners





Wavelength separators and combiners provide spatial separation or combination of different spectral components. These optical elements feature highly reflective dielectric coatings on the front side and antireflective dielectric coatings for transmissive spectral components on the rear side of UV grade fused silica substrates.

Main features

- Substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions are ø25,4 x 5 mm
- 0° or 45° angle of incidence selection
- Custom coatings, substrate material and dimensions are available upon request

Application examples

- Laser separation of the laser fundamental wavelength and its harmonics
- Laser beam combining
- Laser resonator pump (rear) mirror

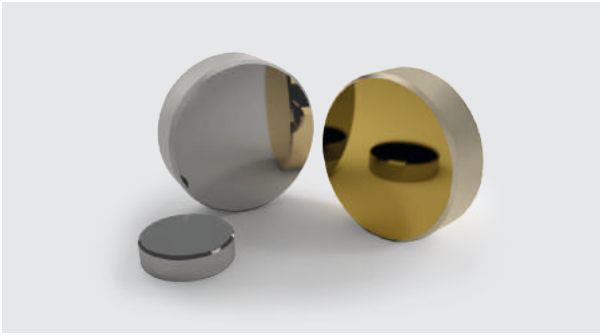
Standard specifications

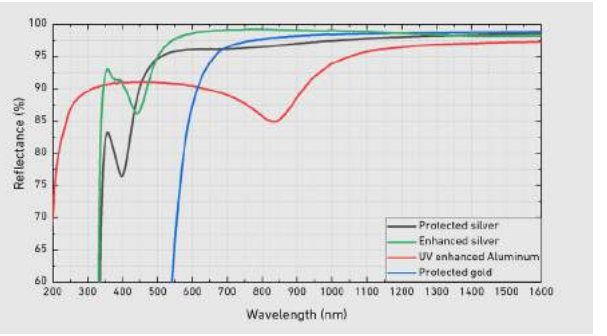
WAVELENGTH SEPARATORS AND COMBINERS	
Substrate material	UV grade fused silica
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm
Laser induced damage threshold	>10 J/cm²@1064 nm, 10 ns (for 1020 nm - 1070 nm reflecting separator)

Standard products

MATERIAL	DIMENSIONS	REFLECTED WAVELENGTH RANGE	TRANSMITTED WAVELENGTH RANGE	AOI	SKU	PRICE
UVFS	ø25,4 x 5 mm	R>99,5%@254-266 nm	T>90%@340-355 nm + 510-535 nm + 1020-1070 nm	0°	6359	88 €
		R>99,5%@340-355 nm	T>93%@510-535 nm + 1020-1070 nm	0°	6544	74 €
		R>99,5%@385-415 nm	T>95%@770-830 nm	0°	6545	74 €
		R>99,5%@510-535 nm	T>95%@1020-1070 nm	0°	6546	74 €
		R>99,5%@770-830 nm	T>95%@385-415 nm	0°	6548	74 €
		R>99,5%@770-830 nm	T>95%@510-535 nm	0°	6547	74 €
		R>99,5%@1020-1070 nm	T>95%@510-535 nm	0°	6549	74 €
		R>99,5%@1020-1070 nm	T>95%@800-810 nm	0°	6550	74 €
		R>99,5%@1020-1070 nm	T>95%@940-980 nm	0°	6551	195 €
		R>99,5%@1520-1570 nm	T>95%@940-980 nm	0°	6552	90 €
		R>99,5%@1890-1990 nm	T>95%@780-820 nm	0°	6553	98 €
		R>99,5%@2000-2100 nm	T>95%@780-820 nm	0°	6554	110 €
		Rs>99,5%, Rp>98,5%@254-266 nm	Ts>85%, Tp>95%@340-355 nm + 510-535 nm + 1020-1070 nm	45°	6555	88 €
		Rs>99,6%, Rp>99,2%@340-355 nm	Ts>91%, Tp>95%@510-535 nm + 1020-1070 nm	45°	6556	74 €
		Rs>99,6%, Rp>99,2%@385-415 nm	Ts>93%, Tp>97%@770-830 nm	45°	6557	74 €
		Rs>99,6%, Rp>99,2%@510-535 nm	Ts>93%, Tp>97%@1020-1070 nm	45°	6558	74 €
		Rs>99,6%, Rp>99,2%@770-830 nm	Ts>93%, Tp>97%@385-415 nm	45°	6560	74 €
		Rs>99,6%, Rp>99,2%@770-830 nm	Ts>93%, Tp>97%@510-535 nm	45°	6559	74 €
		Rs>99,6%, Rp>99,2%@1020-1070 nm	Ts>93%, Tp>97%@510-535 nm	45°	6561	74 €
		Rs>99,6%, Rp>99,2%@1020-1070 nm	Ts>93%, Tp>97%@800-810 nm	45°	6562	74 €
		Rs>99,6%, Rp>99,2%@1020-1070 nm	Ts>93%, Tp>97%@940-980 nm	45°	6563	195 €
		Rs>99,6%, Rp>99,2%@1520-1570 nm	Ts>93%, Tp>97%@940-980 nm	45°	6564	90 €
		Rs>99,6%, Rp>99,2%@1890-1990 nm	Ts>93%, Tp>97%@780-820 nm	45°	6565	98 €
		Rs>99,6%, Rp>99,2%@2000-2100 nm	Ts>93%, Tp>97%@780-820 nm	45°	6566	110 €

Flat and curved metal-coated mirrors





Metal-coated mirrors exhibit a relatively uniform reflectivity over wide wavelength range. They are nearly insensitive to angle of incidence and polarization state of light, thus their reflection losses are significantly higher compared to dielectric thin-film mirrors.

Main features

- Mirror substrates fabricated from high-quality UV grade fused silica
- Standard substrate dimensions are ø25,4 x 5 mm
- UV enhanced aluminum, protected aluminum, protected silver, low GDD enhanced silver and protected gold metallic coatings selection
- Relatively uniform reflectance over a wide wavelength range
- Radius of curvature selection from infinity to -200 mm
- Custom metal-coated mirrors available upon request

Application examples

- Broadband reflectivity and low chromatic dispersion mirrors for white-light interferometers and broadband laser sources
- Partially transmissive broadband mirrors
- Extremely long infrared (up to 20 µm) mirrors
- Plano-convex and plano-concave designs

Standard specifications

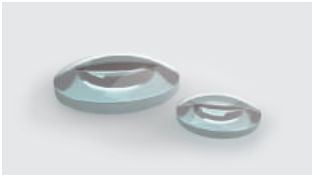
FLAT AND CURVED METAL-COATED MIRRORS	
Substrate material	UV grade fused silica
Substrate dimensions	ø25,4 x 5 mm
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±1 mm
Protective chamfers	<0,35 mm at 45°
Parallelism error	<3 arcmin for plano-plano mirrors
Surface quality	40-20 S-D
Surface flatness	<λ/8@632,8 nm
Laser induced damage threshold	>0,25 J/cm^2@1064 nm, 11 ns for protected aluminum mirrors, >1,8 J/cm^2@1064 nm, 11 ns for protected silver mirrors and for enhanced silver mirrors, >0,9 J/cm^2@1064 nm, 11 ns for protected gold mirrors

Standard products

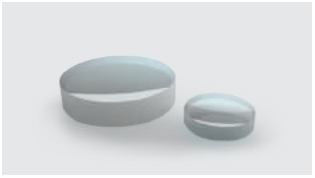
MATERIAL	DIMENSIONS	COATINGS	AVERAGE REFLECTANCE	TYPE	ROC	SKU	PRICE
UVFS	ø25,4 x 5 mm	UV enhanced Aluminum	>80%@230-700 nm	Plano-plano	Infinity	6343	36 €
				Plano-concave	-50 mm	6345	52 €
				Plano-concave	-100 mm	6344	52 €
				Plano-plano	-200 mm	6346	52 €
		Protected Aluminum	>85%@300 nm-IR	Plano-plano	Infinity	6355	28 €
				Plano-concave	-50 mm	6356	46 €
				Plano-concave	-100 mm	6357	46 €
				Plano-concave	-200 mm	6358	46 €
		Protected Silver	>96%@400 nm-IR	Plano-plano	Infinity	6347	36 €
				Plano-concave	-50 mm	6348	50 €
				Plano-concave	-100 mm	6349	50 €
				Plano-concave	-200 mm	6354	50 €
		Enhanced Silver	>99%@700-900 nm	Plano-plano	Infinity	15197	62 €
		Protected Gold	>96%@900 nm-IR	Plano-plano	Infinity	6350	40 €
				Plano-concave	-50 mm	6351	56 €
				Plano-concave	-100 mm	6352	56 €
				Plano-concave	-200 mm	6353	56 €

Lenses

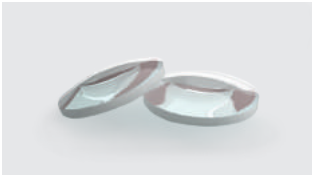
4Lasers provide a variety of spherical, cylindrical and conical lenses fabricated from BK7 and UVFS glasses for UV, VIS and NIR applications. Standard lenses are uncoated, although antireflective coatings are available upon request as well as custom solutions.



Plano-convex spherical lenses

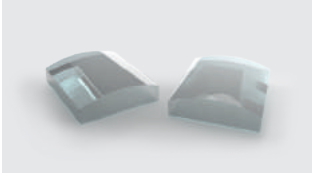


Plano-concave spherical lenses

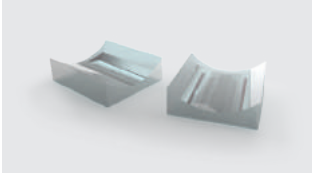


Bi-convex spherical lenses

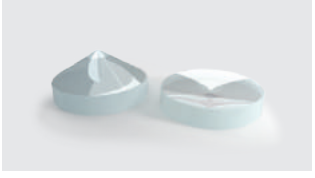
Bi-concave spherical lenses



Plano-convex cylindrical lenses

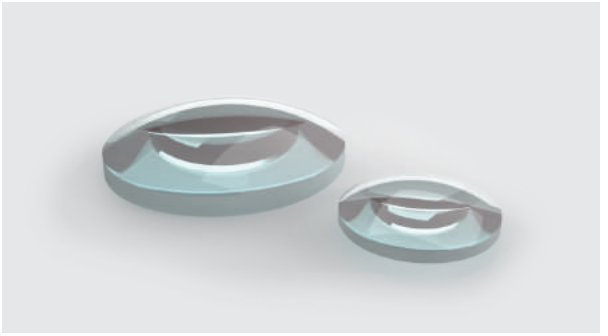


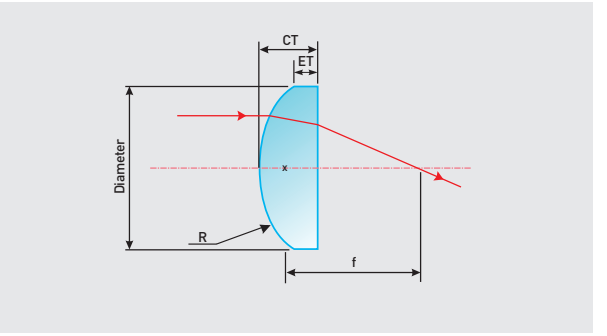
Plano-concave cylindrical lenses



Axicons (conical lenses)

Plano-convex spherical lenses





Plano-convex spherical lenses have one plano and one spherical convex surface, while their focal lengths are positive. These lenses provide the best performance when used for 5X to infinite-conjugate ratio applications, e.g. focusing a collimated light beam or collimating beam from a point source.

Main features

- Fabricated from high-quality UV grade fused silica and BK7 glasses
- Standard diameters are ø12,7 mm and ø25,4 mm
- Focal length selection from 20 mm to 10 000 mm
- Antireflective coatings, custom substrate material, dimensions, and focal lengths available upon request

Application examples

- Focusing a collimated beam
- Collimating beam from a point source
- Beam expanders and collimators

Standard specifications

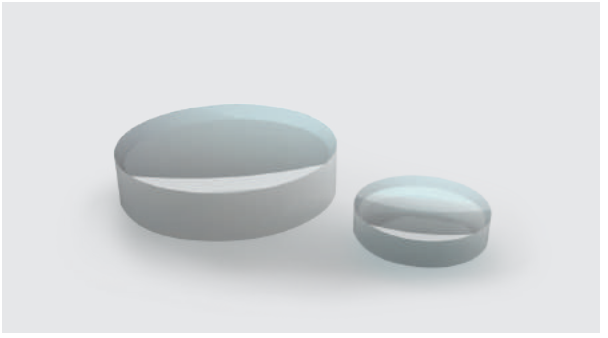
PLANO-CONVEX LENSES	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 lenses: 350 nm - 2 µm Uncoated UVFS lenses: 185 nm - 2,1 µm
Clear aperture	>90%
Diameter tolerance	+0/-0,1 mm
Edge thickness	2 mm
Thickness tolerance	±0,5 mm
Centration error	<3 arcmin
Focal length tolerance	±3%@632,8 nm
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface irregularity	≤λ/8@632,8 nm
Coatings	Uncoated, available upon request

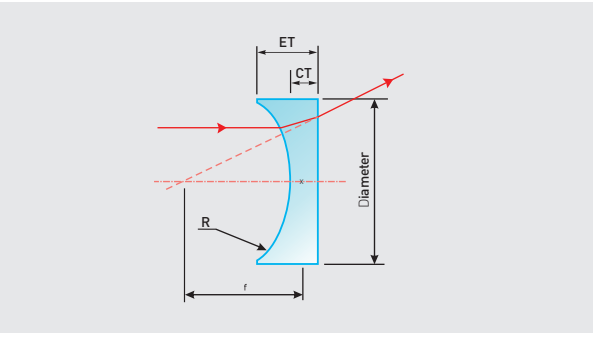
Standard products

MATERIAL	DIAMETER	FOCAL LENGTH	SKU	PRICE
BK7	ø12,7 mm	20 mm	7014	15 €
		40 mm	7015	15 €
		50 mm	7016	15 €
		75 mm	7017	15 €
		100 mm	7018	15 €
		150 mm	7019	15 €
		200 mm	7020	15 €
		250 mm	7021	15 €
		300 mm	7022	15 €
		350 mm	7023	15 €
		500 mm	7024	15 €
		1000 mm	7025	15 €
		1500 mm	7026	15 €
	ø25,4 mm	30 mm	7134	24 €
		40 mm	7135	19 €
		50 mm	7136	19 €
		60 mm	7137	19 €
		75 mm	7138	19 €
		100 mm	7141	19 €
		125 mm	7142	19 €
		150 mm	7143	19 €
		175 mm	7144	19 €
		200 mm	7145	19 €
		250 mm	7146	19 €
		300 mm	7147	19 €
		400 mm	7148	19 €
		500 mm	7149	19 €
		700 mm	7150	19 €
		1000 mm	7151	19 €
		1500 mm	7152	19 €
		2000 mm	7153	19 €
		3000 mm	7154	19 €
		4000 mm	7155	19 €
		5000 mm	7156	19 €
		2500 mm	7157	19 €
		10000 mm	7158	19 €

MATERIAL	DIAMETER	FOCAL LENGTH	SKU	PRICE
UVFS	ø12,7 mm	20 mm	7118	32 €
		40 mm	7119	32 €
		50 mm	7120	32 €
		75 mm	7121	32 €
		100 mm	7122	32 €
		150 mm	7123	32 €
		200 mm	7124	32 €
		300 mm	7125	32 €
		400 mm	7126	32 €
		500 mm	7127	32 €
		700 mm	7128	32 €
		1000 mm	7129	32 €
		1500 mm	7130	32 €
	ø25,4 mm	30 mm	7159	38 €
		40 mm	7160	38 €
		50 mm	7161	38 €
		60 mm	7162	38 €
		75 mm	7163	38 €
		100 mm	7166	38 €
		125 mm	7167	38 €
		150 mm	7168	38 €
		175 mm	7169	38 €
		200 mm	7170	38 €
		250 mm	7171	38 €
		300 mm	7172	38 €
		400 mm	7173	38 €
		500 mm	7174	38 €
		750 mm	7175	38 €
		1000 mm	7176	38 €
		1500 mm	7177	38 €
		2000 mm	7178	38 €
		3000 mm	7179	38 €
		4000 mm	7180	38 €
		5000 mm	7181	38 €
		7000 mm	7182	38 €
		10000 mm	7183	38 €

Plano-concave spherical lenses





Plano-concave spherical lenses have one plano and one spherical concave surface, while their focal lengths are negative. These lenses provide the best performance when used for 5X to infinite-conjugate ratio applications, e.g. collimating a convergent beam, diverging a collimated beam. To prevent spherical aberrations collimated beam should always be incident on curved lens surface and vice versa.

Main features

- Fabricated from high-quality UV grade fused silica and BK7 glasses
- Standard diameters are ø12,7 mm and ø25,4 mm
- Focal length selection from -20 mm to -10000 mm
- Antireflective coatings, custom substrate material, dimensions, and focal lengths available upon request

Application examples

- Collimating a convergent beam
- Diverging a collimated beam
- Relay imaging

Standard specifications

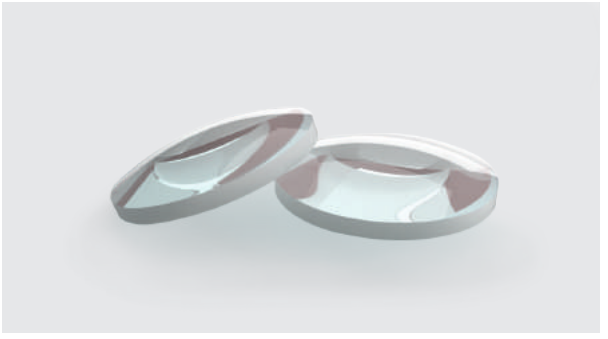
PLANO-CONCAVE LENSES	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 lenses: 350 nm - 2 µm Uncoated UVFS lenses: 185 nm - 2,1 µm
Clear aperture	>90%
Diameter tolerance	+0/-0,1 mm
Edge thickness	2 mm
Thickness tolerance	±0,5 mm
Centration error	<3 arcmin
Focal length tolerance	±3%@632,8 nm
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface irregularity	≤λ/8@632,8 nm
Coatings	Uncoated, available upon request

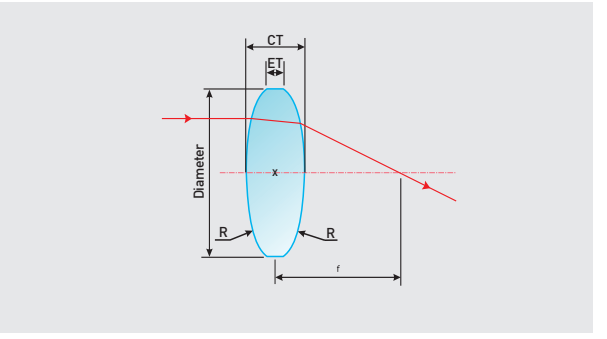
Standard products

MATERIAL	DIAMETER	FOCAL LENGTH	SKU	PRICE
BK7	ø12,7 mm	-25 mm	7507	15 €
		-50 mm	7508	15 €
		-60 mm	7509	15 €
		-75 mm	7510	15 €
		-100 mm	7511	15 €
		-150 mm	7512	15 €
		-200 mm	7513	15 €
		-250 mm	7514	15 €
		-300 mm	7515	15 €
	ø25,4 mm	-30 mm	7525	19 €
		-40 mm	7543	19 €
		-50 mm	7526	19 €
		-75 mm	7527	19 €
		-100 mm	7528	19 €
		-125 mm	7544	19 €
		-150 mm	7545	19 €
		-200 mm	7529	19 €
		-250 mm	7546	19 €
		-300 mm	7530	19 €
		-400 mm	7531	19 €
		-500 mm	7532	19 €
		-750 mm	7547	19 €
		-1000 mm	7533	19 €
		-1500 mm	7549	19 €
		-2000 mm	7548	19 €
		-3000 mm	7550	19 €
		-5000 mm	7551	19 €

MATERIAL	DIAMETER	FOCAL LENGTH	SKU	PRICE
UVFS	ø12,7 mm	-20 mm	7516	32 €
		-50 mm	7518	32 €
		-100 mm	7519	32 €
		-200 mm	7520	32 €
		-300 mm	7521	32 €
		-400 mm	7522	32 €
		-500 mm	7523	32 €
		-1000 mm	7524	32 €
	ø25,4 mm	-30 mm	7534	38 €
		-40 mm	7553	38 €
		-50 mm	7535	38 €
		-60 mm	7554	38 €
		-70 mm	7555	38 €
		-80 mm	7556	38 €
		-90 mm	7557	38 €
		-100 mm	7537	38 €
		-150 mm	7558	38 €
		-200 mm	7538	38 €
		-300 mm	7539	38 €
		-400 mm	7540	38 €
		-500 mm	7541	38 €
		-700 mm	7559	38 €
		-1000 mm	7542	38 €
		-2000 mm	7536	38 €
		-3000 mm	7560	38 €
		-5000 mm	7561	38 €
		-10000 mm	7562	38 €

Bi-convex spherical lenses





Bi-convex spherical lenses feature two convex surfaces with the same radius of curvature, while their focal length is positive. These lenses perform the best at finite conjugate (0,2X - 5X ratio) applications.

At 1:1 conjugate ratio spherical aberrations, coma and distortion are minimized.

Main features

- Fabricated from high-quality UV grade fused silica and BK7 glasses
- Standard diameter is ø25,4 mm
- Focal length selection from 25 mm to 100 mm
- Antireflective coatings, custom substrate material, dimensions, and focal lengths available upon request

Application examples

- Finite-conjugate imaging
- Beam relay applications
- Beam expanders

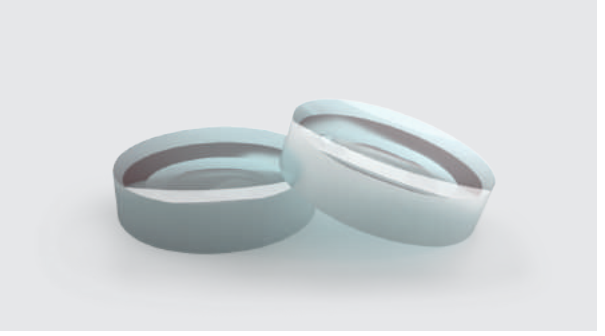
Standard specifications

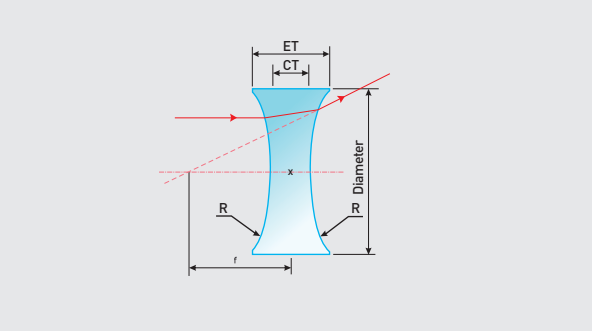
BI-CONVEX SPHERICAL LENSES	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 lenses: 350 nm - 2 µm Uncoated UVFS lenses: 185 nm - 2,1 µm
Clear aperture	>90%
Diameter tolerance	+0/-0,1 mm
Edge thickness	2 mm
Thickness tolerance	±0,5 mm
Centration error	<3 arcmin
Focal length tolerance	±3%@632,8 nm
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface irregularity	≤λ/8@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	DIAMETER	FOCAL LENGTH	SKU	PRICE
BK7	ø25,4 mm	25 mm	7569	28 €
		50 mm	7570	28 €
		75 mm	7571	28 €
		100 mm	7572	28 €
UVFS	ø25,4 mm	25 mm	7565	72 €
		50 mm	7566	72 €
		75 mm	7567	72 €
		100 mm	7568	72 €

Bi-concave spherical lenses





Bi-concave spherical lenses feature two spherical concave surfaces with the same radius of curvature, while their focal length is negative. The performance of these lenses is best when used for finite conjugate (0,2X - 5X ratio) applications, most often to diverge converging light.

Main features

- Fabricated from high-quality UV grade fused silica, BK7 glasses
- Standard diameter is ø25,4 mm
- Focal length selection from -25 mm to -100 mm
- Antireflective coating, custom substrate material, dimensions, and focal lengths available upon request

Application examples

- Beam expanders
- Relay imaging

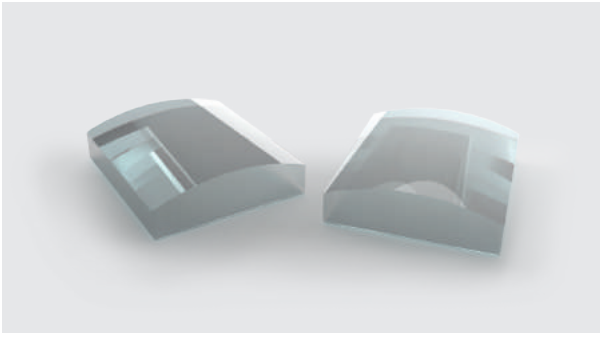
Standard specifications

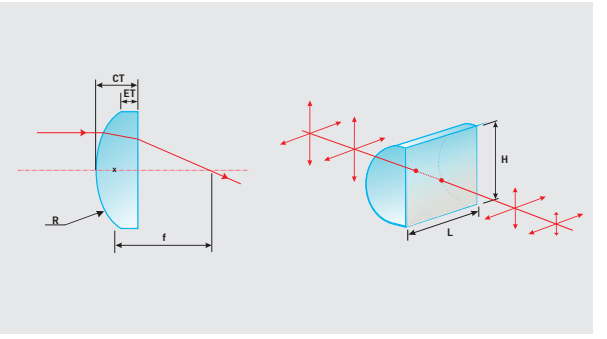
BI-CONCAVE SPHERICAL LENSES	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 lenses: 350 nm - 2 µm Uncoated UVFS lenses: 185 nm - 2,1 µm
Clear aperture	>90%
Diameter tolerance	+0/-0,1 mm
Center thickness	2 mm
Thickness tolerance	±0,5 mm
Centration error	<3 arcmin
Focal length tolerance	±3%@632,8 nm
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface irregularity	≤λ/8@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	DIAMETER	FOCAL LENGTH	SKU	PRICE
BK7	ø25,4 mm	-25 mm	7576	28 €
		-50 mm	7577	28 €
		-75 mm	7578	28 €
		-100 mm	7579	28 €
UVFS	ø25,4 mm	-25 mm	7580	72 €
		-50 mm	7573	72 €
		-75 mm	7574	72 €
		-100 mm	7575	72 €

Plano-convex cylindrical lenses





Plano-convex cylindrical lenses feature single plano and single convex cylindrical surface, while their focal length is positive. These lenses operate only in one dimension rather than two, compared to plano-convex spherical lenses. Plano-convex cylindrical lenses provide the best performance at the same operating conditions as plano-convex spherical lenses: from 5X to finite-conjugate ratio.

Main features

- Fabricated from high-quality UV grade fused silica, BK7 glasses
- Standard face dimensions are 25,4 x 25,4 mm and 25,4 x 50,8 mm
- Focal length selection from 50 mm to 10000 mm
- Antireflective coatings, custom substrate material, dimensions, and focal lengths available upon request

Application examples

- Coupling into a slit or linear shape detectors
- Anamorphic beam shaping
- Astigmatism correction of laser diode beam

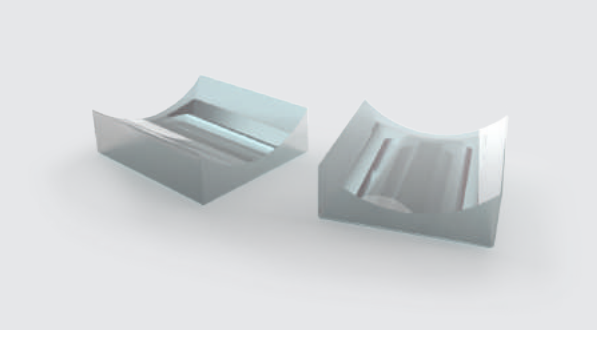
Standard specifications

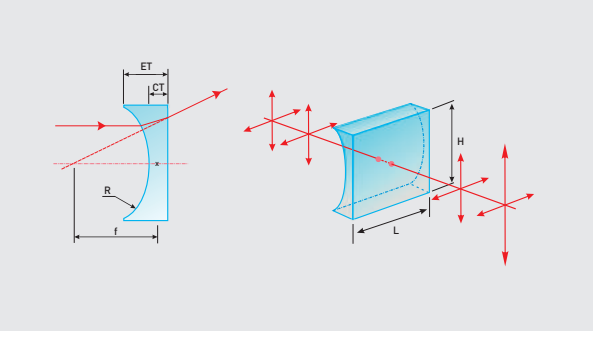
PLANO-CONVEX CYLINDRICAL LENSES	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 lenses: 350 nm - 2 µm Uncoated UVFS lenses: 185 nm - 2,1 µm
Clear aperture	>90%
Diameter tolerance	+0/-0,1 mm
Edge thickness	2 mm
Thickness tolerance	±0,5 mm
Centration error	<3 arcmin
Focal length tolerance	±3%@632,8 nm
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface irregularity	<λ/4@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	FACE DIMENSIONS H X L	FOCAL LENGTH	SKU	PRICE
BK7	25,4 x 25,4 mm	50 mm	7596	Request
		75 mm	7598	Request
		150 mm	7603	Request
		200 mm	7604	Request
		250 mm	7605	Request
		300 mm	7606	Request
		500 mm	7609	Request
	25,4 x 50,8 mm	100 mm	7600	Request
		300 mm	7607	Request
		500 mm	7610	Request
		750 mm	7611	Request
		2000 mm	7612	Request
		10000 mm	7613	Request
UVFS	25,4 x 25,4 mm	50 mm	7587	Request
		75 mm	7589	Request
	25,4 x 50,8 mm	30 mm	7582	Request
		50 mm	7583	Request
		75 mm	7584	Request
		100 mm	7585	Request
		150 mm	7586	Request
		200 mm	7588	Request
		250 mm	7590	Request
		300 mm	7591	Request
		400 mm	7592	Request
		500 mm	7593	Request
		750 mm	7594	Request
		1000 mm	7595	Request

Plano-concave cylindrical lenses





Plano-concave cylindrical lenses feature single plano, single concave cylindrical surface and negative focal length. These lenses are similar to plano-concave spherical lenses, though the difference is that they operate only in a single dimension rather than two symmetrical dimensions. Applicable conditions for optimal performance are the same as for plano-concave lenses: from 5X to infinite-conjugate ratio.

Main features

- Fabricated from high-quality UV grade fused silica, BK7 glasses
- Standard face dimensions are 25,4 x 25,4 mm and 25,4 x 50,8 mm
- Focal length selection from -25 mm to -1000 mm
- Antireflective coatings, custom substrate material, dimensions, and focal lengths available upon request

Application examples

- Anamorphic beam shaping
- Laser projection
- Laser scanning

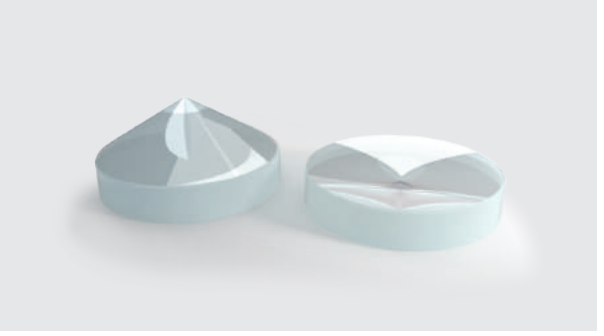
Standard specifications

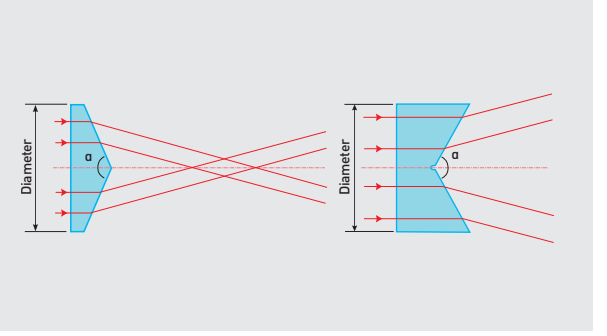
PLANO-CONVEX CYLINDRICAL LENSES	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 lenses: 350 nm - 2 µm Uncoated UVFS lenses: 185 nm - 2,1 µm
Clear aperture	>90%
Diameter tolerance	+0/-0,1 mm
Center thickness	2 mm
Thickness tolerance	±0,5 mm
Centration error	<3 arcmin
Focal length tolerance	±3%@632,8 nm
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface irregularity	<λ/4@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	FACE DIMENSIONS H X L	FOCAL LENGTH	SKU	PRICE
BK7	25,4 x 25,4 mm	-50mm	7621	Request
		-75 mm	7622	Request
		-100 mm	7625	Request
		-200 mm	7626	Request
		-500 mm	7628	Request
	25,4 x 50,8 mm	-50mm	7623	Request
		-75 mm	7624	Request
		-200 mm	7631	Request
		-500 mm	7627	Request
UVFS	25,4 x 25,4 mm	-25 mm	7614	Request
		-50 mm	7629	Request
	25,4 x 50,8 mm	-50 mm	7630	Request
		-100 mm	7615	Request
		-200 mm	7616	Request
		-300 mm	7617	Request
		-400 mm	7618	Request
		-500 mm	7619	Request
		-1000 mm	7620	Request

Axicons (conical lenses)





Axicons (conical lenses) are famous for their ability to transform a collimated Gaussian beam into an approximation of non-diffracting Bessel beam in the near-field and ring-shaped beam in the far-field. Most often they are used in tandem with other types of lenses. 4Lasers provide plano-convex and plano-concave types of conical lenses. These lenses feature one convex surface or one concave conical surface, respectively, while second surface is plano in both cases.

Main features

- Fabricated from high-quality UV grade fused silica, BK7 glasses
- Plano-convex and plano-concave designs
- Regular and advanced grade axicons
- Wide axicon apex angle selection
- Antireflective coatings, customization available upon request

Application examples

- Corneal surgery
- Optical coherence tomography
- Atom trapping

Standard specifications

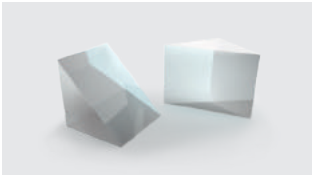
AXICONS		
Type	Plano-convex	Plano-concave
Substrate material	BK7, UVFS	UVFS
Wavelength range	Uncoated BK7 axicons: 350 nm - 2 µm Uncoated UVFS axicons: 185 nm - 2,1 µm	
Clear aperture	>90%	>90%
Diameter tolerance	+0/-0,1 mm	+0/-0,1 mm
Apex rounding	Regular: <ø1 mm Advanced: <ø0,4 mm	N/A
Angle tolerance	Regular: ±0,5° Advanced: ±0,1°	Regular: ±0,5°
Central hole	N/A	Regular: ~ø1 mm, depth ~2 mm
Protective chamfers	<0,35 mm at 45°	<0,35 mm at 45°
Surface quality	Regular: 60-40 S-D Advanced: 40-20 S-D	Regular: 60-40 S-D
Surface irregularity	Regular: <1λ@632,8 nm Advanced: <λ/4@632,8 nm	Regular: <1λ@632,8 nm
Coatings	Uncoated	Uncoated

Standard products

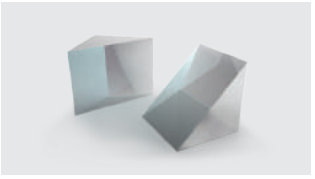
MATERIAL	SHAPE	GRADE	DIAMETER	APEX ANGLE	SKU	PRICE
BK7	Plano-convex	Regular	ø25,4 mm	140°	7640	160 €
				160°	7641	160 €
				170°	7642	160 €
				175°	7643	160 €
				178°	7644	160 €
UVFS	Plano-convex	Advanced	ø25,4 mm	130°	7632	360 €
				140°	7633	360 €
				160°	7634	360 €
				170°	7635	360 €
				175°	7636	360 €
				176°	7637	360 €
				178°	7638	360 €
				179°	7639	360 €
	Plano-concave	Regular	ø25,4 mm	140°	7645	480 €
				160°	7646	480 €
				170°	7647	480 €
				175°	7648	480 €
				179°	7649	480 €

Prisms

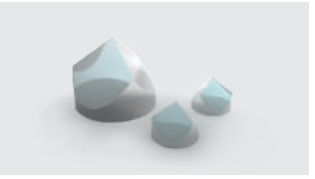
4Lasers provide uncoated and unmounted dispersing prisms, HR right-angle retroreflectors, corner cube retroreflectors and penta prisms for UV, VIS and NIR applications. Applications of these prisms include beam bending, folding, retroreflecting, optical alignment and more. Since most of the prisms are initially uncoated, we recommend applying the appropriate coatings to optimize the performance. Metallic and dielectric thin-film coatings are available upon demand.



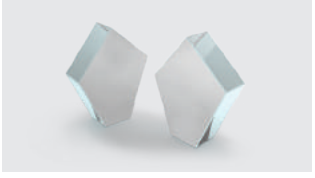
Dispersing prisms



Right-angle prisms



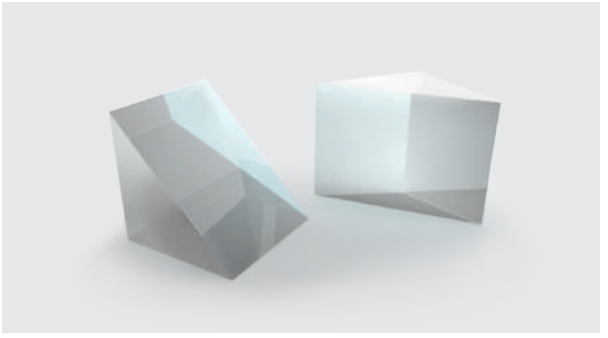
Corner cube retroreflectors

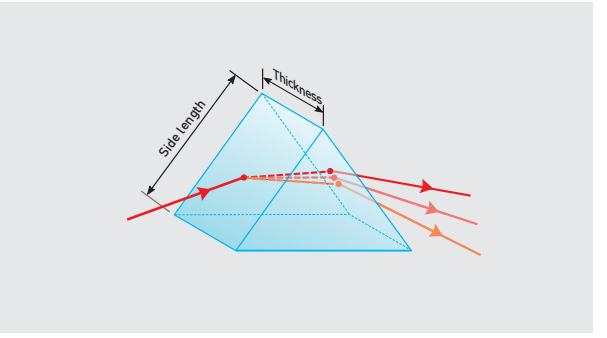


Penta prisms

HR right-angle retroreflectors

Dispersing prisms





4Lasers standard uncoated isosceles dispersing prisms are fabricated from UVFS, BK7, SF11 optical glasses and offer different dispersive properties. Used in both intra- and extra-cavity setups for ultrashort laser pulse temporal manipulation. Their construction enables to use them at Brewster angle, therefore p-polarized light losses are extremely low.

Main features

- Fabricated from high-quality UV fused silica, BK7, SF11 glasses
- Input and output faces are optically polished (refer to the drawing)
- Small losses for p-polarized light
- Group delay dispersion adjustment of ultrashort pulses
- Antireflective coatings, custom design, substrate material and dimensions available upon request

Application examples

- Compression of ultrashort laser pulses
- Dispersion compensation in mode-locked lasers
- Spatial separations of different spectral components

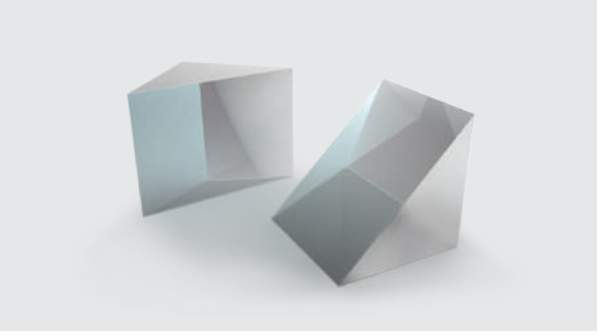
Standard specifications

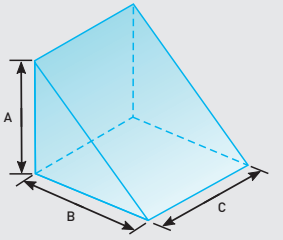
DISPERSING PRISMS	
Substrate material	BK7, SF11, UVFS
Wavelength range	Uncoated BK7 prisms: 350 nm - 2 µm Uncoated UVFS prims: 185 nm - 2,1 µm Uncoated SF11 prisms: 420 nm - 2,3 µm
Design wavelength	800 nm
Clear aperture	80% of face and length width
Dimensions tolerance	±0,25 mm
Angle tolerance	±2 arcmin
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface flatness	≤λ/4@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	APEX ANGLE	THICKNESS	SIDE LENGTH	MAX INPUT BEAM DIAMETER	SKU	PRICE
SF11	59°	10 mm	15 mm	6 mm	6617	49 €
		18 mm	25 mm	12 mm	6622	95 €
		25 mm	50 mm	22 mm	6623	195 €
BK7	67°	10 mm	15 mm	6 mm	6615	40 €
		18 mm	25 mm	12 mm	6618	69 €
		25 mm	50 mm	22 mm	6619	140 €
UVFS	69°	10 mm	15 mm	6 mm	6616	72 €
		18 mm	25 mm	12 mm	6620	125 €
		25 mm	50 mm	22 mm	6621	260 €

Right-angle prisms





4Lasers standard uncoated right-angle (45°-90°-45°) design prisms are fabricated from UVFS and BK7 optical glasses and have three optically polished rectangular surfaces (refer to the drawing). These prisms are popular at 90° internal or external beam bending, 180° beam folding, image rotation. These applications are based on the total internal reflection at glass-air boundary inside the prism, except 90° external beam bending, which requires metallic or highly reflective dielectric thin film to be applied onto the hypotenuse face. Antireflective coatings have to be applied in order to optimize the optical transmission for a particular application. Contact us for coating service, custom solutions, and pricing.

Main features

- Fabricated from high-quality UV grade fused silica, BK7
- Rectangular faces are optically polished
- Standard and advanced grade selection
- Metallic and dielectric thin-film coatings, custom substrate material and dimensions are available upon request

Application examples

- 90° internal or external mirror
- Retroreflector
- Components for cube beamsplitter

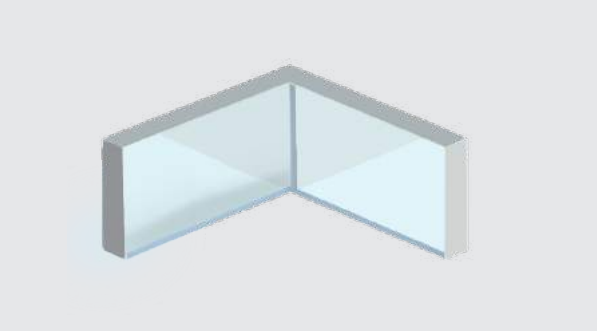
Standard specifications

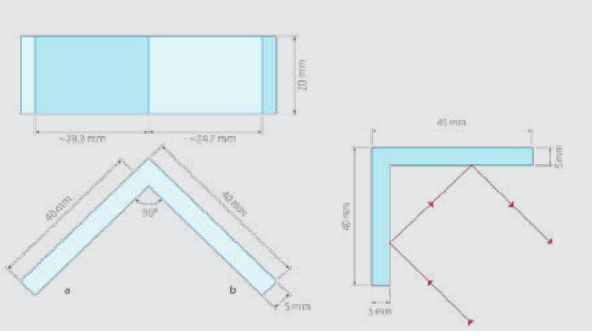
RIGHT-ANGLE PRISMS	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 prisms: 350 nm - 2 µm Uncoated UVFS prisms: 185 nm - 2,1 µm
Clear aperture	≥80% of face dimensions
Dimensions tolerance	+0/-0,25 mm
90° angle tolerance	Regular grade: ±2 arcmin Advanced grade: ±5 arcsec
Pyramidal tolerance	Regular grade: ±1 arcmin Advanced grade: ±30 arcsec
Protective chamfers	<0,25 mm at 45°
Surface quality	40-20 S-D
Surface flatness	≤λ/4@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	DIMENSIONS A = B = C	GRADE	SKU	PRICE
BK7	5 mm	Regular	6570	18 €
	10 mm	Regular	6571	20 €
		Advanced	6572	42 €
	20 mm	Regular	6573	31 €
		Advanced	6574	57 €
UVFS	5 mm	Regular	6576	45 €
	10 mm	Regular	6575	49 €
		Advanced	6567	93 €
	20 mm	Regular	6568	59 €
		Advanced	6569	116 €

HR right-angle retroreflectors





4Lasers HR right-angle retroreflectors consist of two highly reflective mirrors glued at right angle with precision as high as <30 arcsec. Hollow design eliminates the material dispersion, which is inherent in common retroreflector prisms, making them perfect for ultrashort pulse back reflection applications.

Right angle retroreflectors are manufactured from high quality UVFS substrates, coated with low GDD high reflective coatings designed for Ti:Sapphire, Erbium and Ytterbium doped host based femtosecond laser.

Main features

- Fabricated from high-quality UV grade fused silica
- Reflectance Rs>99,6% per surface
- Coating stack is designed to have low dispersion (GDD) for the reflected wavelengths
- Custom coatings, substrate material and dimensions are available upon request

Application examples

- Ultrashort pulse back reflection
- Delay lines

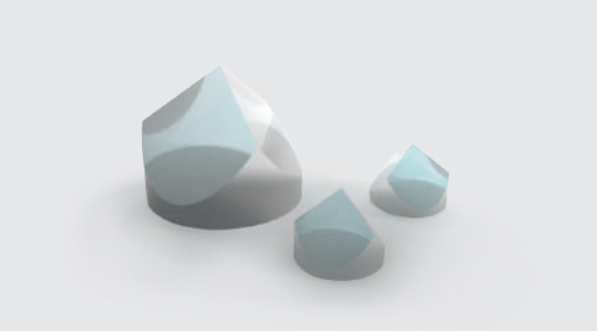
Standard specifications

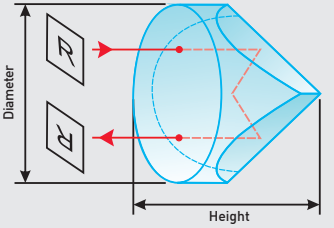
HR RIGHT-ANGLE RETROREFLECTORS	
Substrate material	UVFS
Aperture dimensions	16 mm
Substrate dimensions	40x20x5 mm
Face dimensions tolerance	+0/-0,1 mm
Thickness tolerance	±0,2 mm
Surface quality	20-10 S-D
Surface flatness	<λ/6@632,8 nm
90° angle tolerance	±30 arcsec
Pyramidal error	<1 arcmin
Protective chamfers	<0,25 mm at 45°
AOI	45°

Standard products

MATERIAL	APERTURE DIMENSIONS	REFLECTANCE	AOI	WAVELENGTH RANGE	SKU	PRICE
UVFS	16 mm	Rs>99,6%, Rp>99,2%	45°	510-535 nm	28475	290 €
				760-840 nm	28476	340 €
				1020-1070 nm	28474	290 €
				1520-1570 nm	28477	340 €

Corner cube retroreflectors





4Lasers standard uncoated corner cube retroreflectors are fabricated from high-quality UVFS and BK7 optical glasses. Corner cube retroreflector prisms provide the beam deviation by 180° and creates an inverted, reversed image independent of the angle of incidence, with a wide incident angle acceptance range. Operating principle is based on three total internal reflections inside the prism. Antireflective coatings have to be applied in order to optimize the optical transmission for a particular application. Contact us for coating service, custom solutions and pricing.

Main features

- Fabricated from high-quality UV grade fused silica, BK7 optical glasses
- Provides high-precision angle insensitive retroreflection (180° ± 30 arcsec)
- Inverts and reverses the image
- Antireflective coatings, custom material and dimensions available upon request

Application examples

- Beam alignment
- Retroreflectors

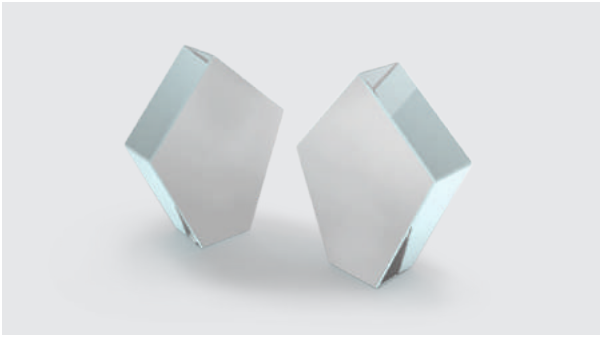
Standard products

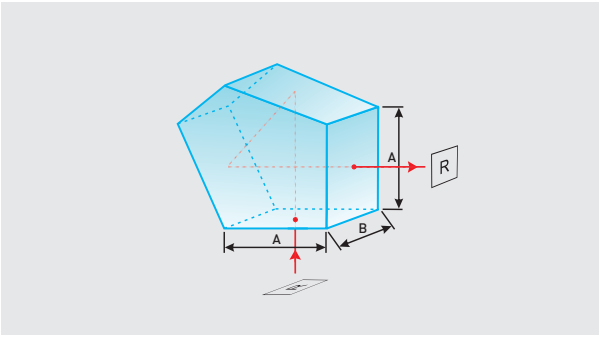
MATERIAL	DIAMETER	HEIGHT	SKU	PRICE
BK7	ø25,4 mm	17,5 mm	7564	140 €
UVFS	ø25,4 mm	17,5 mm	7563	185 €

Standard specifications

CORNER CUBE RETROREFLECTORS	
Substrate material	BK7, UVFS
Beam deviation	180° ± 30 arcsec
Wavelength range	Uncoated BK7 reftoreflectors: 350 nm - 2 µm Uncoated UVFS retroreflectors: 185 nm - 2,1 µm
Clear aperture	>80% of face dimensions
Dimensions tolerance	+0/-0,3 mm
Angle tolerance	±5 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface flatness	<λ/4@632,8 nm
Coatings	Uncoated, available upon request

Penta prisms





4Lasers unmounted penta prisms provide 90° beam and image deviation without inverting or reversing the image. Penta prisms reflecting surfaces are aluminized with inconel and black paint overcoat, while input and output faces are uncoated (refer to the drawing). An important feature is that these prisms do not have to be precisely aligned to operate properly. Therefore, these five-sided reflecting design prisms are essential for applications, where precise 90° deviation is required. Antireflective coatings have to be applied in order to optimize the optical transmission for a particular application. Contact us for coating service, custom solutions and pricing.

Main features

- Fabricated from high-quality BK7 glass
- 90° ± 1 arcmin deviation
- Does not invert, reverse beam or image
- <λ/10@632,8 nm surface flatness over clear aperture
- Antireflective coatings on input and output faces, custom substrate material and dimensions upon request

Application examples

- Beam steering
- Optical system alignment

Standard products

MATERIAL	FACE DIMENSIONS A X B	SKU	PRICE
BK7	10 x 10 mm	7433	Request
	20 x 20 mm	7434	Request
	40 x 40 mm	7435	Request
	60 x 60 mm	7436	Request

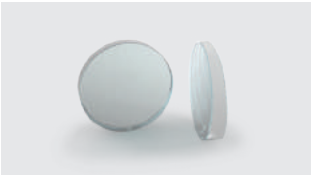
Standard specifications

PENTA PRISMS	
Beam deviation	90°± 1 arcmin
Wavelength range	Uncoated BK7 prisms: 350 nm - 2 µm
Clear aperture	>70% of face dimensions length and width
Dimensions tolerance	±0,1 mm
Angular tolerance	±1 arcmin
Protective chamfers	<0,35 mm at 45°
Surface quality	40-20 S-D
Surface flatness	<λ/10@632,8 nm over clear aperture
Coatings	Reflecting surfaces: aluminized with inconel and black paint overcoat Input and output surfaces: uncoated

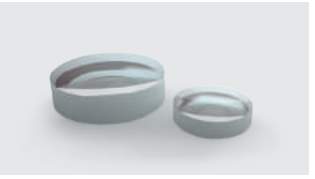
Windows

4Lasers provide uncoated flat-parallel windows, flat-wedge windows, and curved windows fabricated from UVFS and BK7 optical glasses for UV, VIS and NIR applications. These optical components are the substrates of mirrors, output couplers and beamsplitters in any kind of laser and non laser systems. They are initially uncoated and demand metallic or dielectric coatings for a particular application. 4Lasers provide coating service upon request. Contact us for custom solutions and pricing.

Flat-parallel windows

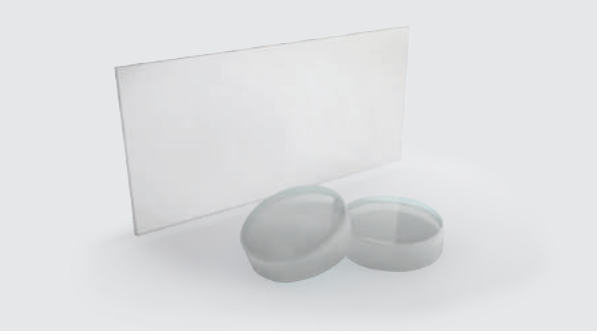


Flat-wedge windows



Curved windows

Flat-parallel windows



Standard uncoated flat-parallel windows are fabricated from BK7 or UV grade fused silica optical glass. UV grade fused silica glass windows are a good option for UV, ultrashort pulse, and high-power laser applications due to their low sensitivity to temperature variations, relatively high damage threshold and UV transmission down to 185 nm.

BK7 glass windows are a cost-effective choice for visible and near-infrared range, low/mid-power laser and non-laser applications. These components are initially uncoated and demand metallic or dielectric coatings for a particular application. 4Lasers provide coating service upon request. Contact us for custom solutions and pricing.

Main features

- Fabricated from high-quality UV grade fused silica, BK7 glasses
- Optically polished surfaces
- Available in round or rectangular shape with various thicknesses
- Custom coated and uncoated windows are available upon request

Application examples

- Substrates of mirrors and beamsplitters
- Isolation of different physical environments
- Beam sampling

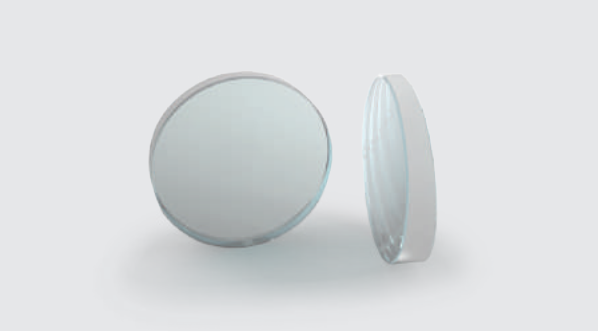
Standard specifications

FLAT-PARALLEL WINDOWS	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 windows: 350 nm - 2 µm Uncoated UVFS windows: 185 nm - 2,1 µm
Clear aperture	>85%
Face dimensions tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	≤ø50,8 mm:<0,35 mm at 45° >ø50,8 mm:<0,50 mm at 45°
Surface quality	≤ø25,4 mm: 10-5 S-D >ø25,4 mm: 20-10 S-D
Transmitted wavefront distortion	≤ø25,4 mm:<λ/8@632,8 nm >ø25,4 mm:<λ/5@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	FACE DIMENSIONS	THICKNESS	SURFACE FLATNESS	SKU	PRICE
BK7	ø25,4 mm	6,35 mm	<λ/8@632,8 nm	6247	14 €
	ø38,1 mm	6,35 mm	<λ/5@632,8 nm	6248	24 €
	ø50,8 mm	6,35 mm	<λ/5@632,8 nm	6249	32 €
	ø50,8 mm	9,525 mm	<λ/5@632,8 nm	6250	34 €
	ø76,2 mm	12,7 mm	<λ/4@632,8 nm	6253	100 €
	ø101,6 mm	12,7 mm	<λ/4@632,8 nm	6254	160 €
UVFS	ø12,7 mm	2 mm	<λ/4@632,8 nm	6241	14 €
	ø12,7 mm	6 mm	<λ/8@632,8 nm	6242	14 €
	ø25,4 mm	2 mm	<λ/2@632,8 nm	6222	16 €
	ø25,4 mm	5 mm	<λ/8@632,8 nm	6223	16 €
	ø38,1 mm	6,35 mm	<λ/5@632,8 nm	6244	30 €
	ø50,8 mm	6,35 mm	<λ/5@632,8 nm	6245	68 €
	ø50,8 mm	9,525 mm	<λ/4@632,8 nm	6246	74 €
	ø76,2 mm	12,7 mm	<λ/4@632,8 nm	6251	170 €
	ø101,6 mm	12,7 mm	<λ/4@632,8 nm	6252	280 €
	20 x 40 mm	5 mm	<λ/6@632,8 nm	6243	40 €

Flat-wedge windows



Windows with a slight wedge are commonly used to prevent harmful laser cavity feedback and beam interference effects. Standard 4Lasers uncoated flat-wedge windows are fabricated from BK7 and UV grade fused silica optical glass. UV grade fused silica glass flat-wedge window is a good option for UV, ultrashort pulse and high-power laser applications because of a low sensitivity to temperature variations, relatively high damage threshold and UV transmission down to 185 nm. BK7 glass window is a cost-effective choice for visible and near-infrared range, low or mid-power laser and non-laser applications.

Main features

- Fabricated from high-quality, laser grade polished UV grade fused silica, BK7 glasses
- Standard diameters are ø12,7 mm, ø25,4 and ø50,8 mm
- Wedge angle selection from 0,5° to 3°
- Coatings, custom substrate material, dimensions are available upon request

Application examples

- Protection from undesirable laser cavity feedback
- Elimination of fringe pattern due to back reflections
- Variable beam steering
- Beam sampling

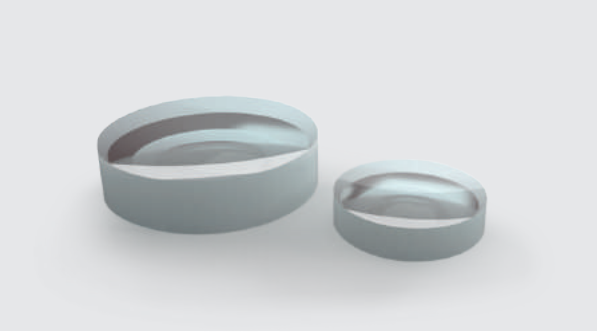
Standard specifications

FLAT-WEDGE WINDOWS	
Substrate material	BK7, UVFS
Wavelength range	Uncoated BK7 windows: 350 nm - 2 µm Uncoated UVFS windows: 185 nm - 2,1 µm
Clear aperture	>85%
Diameter tolerance	+0/-0,15 mm
Thickness tolerance	±0,25 mm
Wedge tolerance	±5 arcmin
Protective chamfers	<0,35 mm at 45°
Surface quality	ø≤25,4 mm: 10-5 S-D ø>25,4 mm: 20-10 S-D
Surface flatness	ø≤25,4 mm:<λ/8@632,8 nm ø>25,4 mm:<λ/5@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	FACE DIMENSIONS	THICKNESS	WEDGE ANGLE	SKU	PRICE
BK7	ø12,7 mm	5 mm	0,5°	6277	18 €
	ø25,4 mm	3 mm	1°	6278	30 €
	ø25,4 mm	6,35 mm	3°	6279	30 €
	ø50,8 mm	6,35 mm	1°	6280	54 €
UVFS	ø12,7 mm	5 mm	0,5°	6225	20 €
	ø25,4 mm	3 mm	1°	6274	32 €
	ø25,4 mm	6,35 mm	3°	6275	32 €
	ø50,8 mm	6,35 mm	1°	6276	74 €

Curved windows



Curved windows are an excellent choice as a substrate of reflective and refractive optical elements. Commonly metallic or dielectric thin-film coatings are applied onto the windows surfaces to be used for a particular application. Standard 4Lasers uncoated curved windows are fabricated from UV grade fused silica glass material. UV grade fused silica glass curved windows are a good option for UV, ultrashort pulse and high-power laser applications because of a low sensitivity to temperature variations, relatively high damage threshold and UV transmission down to 185 nm.

Main features

- Fabricated from high-quality UVFS glass
- Plano-convex or plano-concave design
- Radii of curvature selection from -1000 mm to 1000 mm
- Coatings, custom substrate material, dimensions are available upon request

Application examples

- High reflectivity mirrors, output couplers in laser resonators
- Reflective and refractive optical elements in beam expanders, collimators, reducers, telescopes

Standard specifications

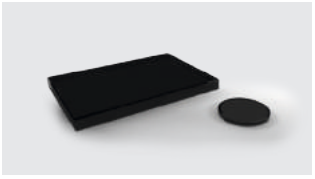
CURVED WINDOWS	
Substrate material	UVFS
Wavelength range	Uncoated UVFS windows: 185 nm - 2,1 µm
Clear aperture	>85%
Diameter tolerance	+0/-0,1 mm
Thickness tolerance	±0,5 mm
Radius of curvature tolerance	<1%
Centration error	<3 arcmin
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface irregularity	<λ/8@632,8 nm
Coatings	Uncoated, available upon request

Standard products

MATERIAL	FACE DIMENSIONS	TYPE	EDGE THICKNESS	ROC	SKU	PRICE
UVFS	ø25,4 mm	Plano-concave	5 mm	-50 mm	6220	55 €
				-100 mm	6256	55 €
				-200 mm	6259	55 €
				-600 mm	6261	55 €
				-1000 mm	6263	55 €
		Plano-convex	3,36 mm	+50 mm	6269	55 €
			4,19 mm	+100 mm	6270	55 €
			4,6 mm	+200 mm	6271	55 €
			4,84 mm	+500 mm	6272	55 €
			4,92 mm	+1000 mm	6273	55 €

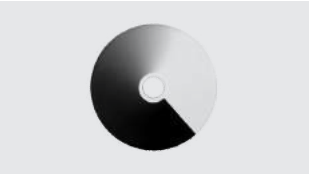
Filters

4Lasers provide neutral density absorption filters with flat transmission characteristics over a particular wavelength range. Also, bandpass (interference) filters, which selectively transmit particular wavelength range and eliminate out of band spectral components. Custom filters are available upon request. Contact us for solutions and pricing.



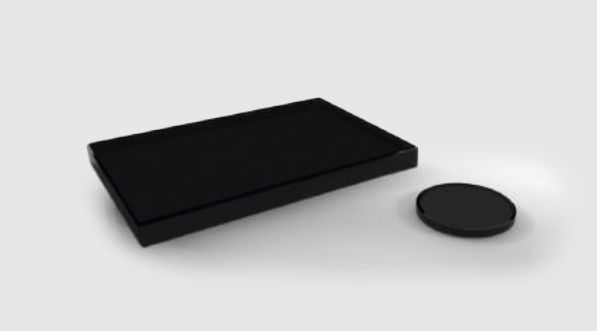
Neutral density absorption filters

Bandpass (interference) filters



Circular variable neutral density filters

Neutral density (by absorption) filters



Neutral density (by absorption) filters are designed for a flat transmission over a particular wavelength range and defined by the optical density (OD). Overall optical attenuation is a sum of optical absorption in neutral density optical glass and Fresnel reflection losses. Neutral density optical filter densities add up when used in series.

Main features

- Optical density selection from 0,1 to 4
- ø25,4 mm standard diameter
- Excellent for low-power applications
- Custom dimensions, optical densities are available upon request

Application examples

- Overexposure prevention for cameras and other detectors
- Laser power attenuation

Standard specifications

NEUTRAL DENSITY (BY ABSORPTION) FILTERS	
Material	Neutral density optical glass
Design wavelength	450-650 nm
Optical density tolerance	±5%
Clear aperture	>85%
Face dimensions tolerance	+0/-0,2 mm
Parallelism error	<3 arcmin
Protective chamfers	<0,35 mm at 45°
Surface quality	60-40 S-D
Surface flatness	<1λ@632,8 nm
Coatings	Uncoated, available upon request

Standard products

FACE DIMENSIONS	DESIGN WAVELENGTH	OPTICAL DENSITY	TRANSMISSION	SKU	PRICE
ø25,4 mm	450-650 nm	0,1	79%	6498	25 €
		0,2	63%	6499	25 €
		0,3	50%	6500	25 €
		0,4	40%	6501	25 €
		0,5	32%	6502	25 €
		1	10%	6503	25 €
		1,5	3%	6504	25 €
		2	1%	6505	26 €
		3	0,1%	6506	28 €
		4	0,01%	6507	29 €

Bandpass (interference) filters

4Lasers bandpass (interference) filters selectively transmit specific spectral components, while eliminating the ones out of band. They are designed to be used with collimated light and at normal angle of incidence.

Each of these filters is mounted in a black anodized aluminum mount with a propagation direction mark on it. Customization of central wavelength, peak transmission and bandwidth is available upon request.

Main features

- Out of band transmission <0,01%
- Central wavelength selection from 355 nm to 1064 nm
- Standard mount size is ø25,4 x 6,3 mm

Application examples

- Fluorescence microscopy
- Spectroscopy
- Imaging

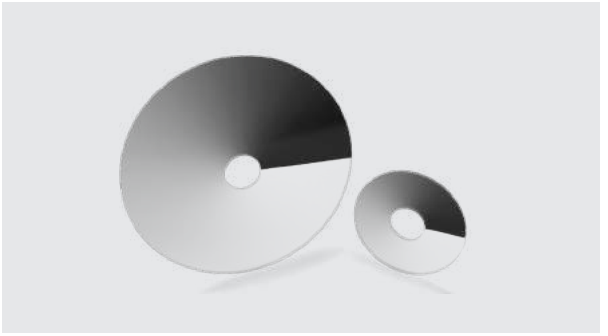
Standard specifications

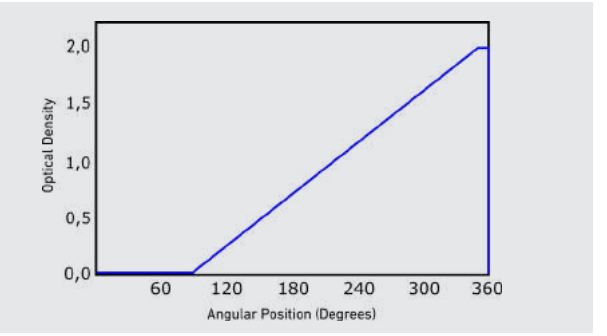
BANDPASS (INTERFERENCE) FILTERS	
Center wavelength tolerance	±2 nm
Out of band transmission	<0,01%
Bandwidth tolerance	±2 nm
Clear aperture	>80%
Surface quality	80-50 S-D
Mount	ø25,4 x 6,3 mm black anodized aluminum mount

Standard products

CENTER WAVELENGTH	PEAK TRANSMISSION	BANDWIDTH (FWHM)	BLOCKING RANGE	TYPICAL APPLICATION	SKU	PRICE
355 nm	≥25%	10 nm	200-3000 nm	Nd:YAG laser line	6465	Request
460 nm	≥65%	10 nm	200-1150 nm	Argon laser line	6466	Request
488 nm	≥65%	10 nm	200-1150 nm	Argon laser line	6467	Request
514,5 nm	≥65%	10 nm	200-1150 nm	Argon laser line	6468	Request
532 nm	≥70%	10 nm	200-1150 nm	Nd:YAG laser line	6469	Request
543,5 nm	≥70%	10 nm	200-1150 nm	HeNe laser line	6470	Request
600 nm	≥50%	10 nm	200-1200 nm	General	6471	Request
635 nm	≥70%	10 nm	200-1150 nm	Diode	6472	Request
647,1 nm	≥70%	10 nm	200-1150 nm	Krypton laser line	6473	Request
694 nm	≥70%	10 nm	200-1150 nm	Ruby laser line	6474	Request
730 nm	≥70%	10 nm	200-1150 nm	Diode	6475	Request
780 nm	≥70%	10 nm	200-1150 nm	Diode	6476	Request
800 nm	≥50%	10 nm	200-1200 nm	General	6477	Request
810 nm	≥50%	10 nm	200-1200 nm	General	6478	Request
850 nm	≥70%	10 nm	200-1150 nm	Diode	6479	Request
905 nm	≥70%	10 nm	200-1150 nm	Diode	6480	Request
940 nm	≥50%	10 nm	200-1200 nm	General	6481	Request
980 nm	≥50%	10 nm	200-1200 nm	General	6482	Request
1064 nm	≥70%	10 nm	200-1150 nm	Nd:YAG laser line	6483	Request

Circular variable neutral density filters





Circular ND filters provide continuously variable, linear attenuation of light intensity by rotating the filter around its center. Transmitted intensity varies as a function of the optical density range. The filter can be used for natural light and also for laser applications.

By using two filters in combination in reverse rotation can obtain a fixed density attenuation and extends the number applications. Sizes are available from 25 mm to 100 mm in diameter.

Main features

- Wide operational wavelength range (250-2500 nm with UVFS substrate)
- Maintains the transmitted spectral profile

Application examples

- Continuously variable light attenuation over a broad wavelength range

Standard specifications

CIRCULAR VARIABLE NEUTRAL DENSITY FILTERS	
Substrate material	BK7 or UVFS
Operating wavelength range	380-2000 nm (BK7) 250-2500 nm (UVFS)
Type	Reflective metal coated (gradient thickness metal layer)
Calibration wavelength	532 nm
Inner hole diameter	8,0 mm
Inner hole diameter tolerance	+0,15/-0,00 mm
Outside diameter tolerance	+0,00/-0,15 mm
Thickness	1,75 mm
Surface flatness	<λ @ 632,8 nm
Surface quality	60-40 S-D
Clear aperture	>90%
Coated area	0-270 deg
Parallelism	<3 arcmin

Standard products

SUBSTRATE MATERIAL	OPERATING RANGE	OUTER DIAMETER	OPTICAL DENSITY RANGE	AVERAGE TRANSMISSION IN VIS	SKU	PRICE
BK7	380-2000 nm	ø25 mm	0,04-1	90% to 10%	15676	165 €
			0,04-2	90% to 1%	15677	165 €
			0,04-3	90% to 0,1%	15678	165 €
		ø50 mm	0,04-1	90% to 10%	15679	210 €
			0,04-2	90% to 1%	15680	210 €
			0,04-3	90% to 0,1%	15681	210 €
		ø100 mm	0,04-1	90% to 10%	15682	285 €
			0,04-2	90% to 1%	15683	285 €
			0,04-3	90% to 0,1%	15684	285 €
UVFS	250-2500 nm	ø25 mm	0,04-1	90% to 10%	15685	205 €
			0,04-2	90% to 1%	15686	205 €
			0,04-3	90% to 0,1%	15687	205 €
		ø50 mm	0,04-1	90% to 10%	15688	250 €
			0,04-2	90% to 1%	15689	250 €
			0,04-3	90% to 0,1%	15690	250 €
		ø100 mm	0,04-1	90% to 10%	15691	325 €
			0,04-2	90% to 1%	15692	325 €
			0,04-3	90% to 0,1%	15693	325 €

Polarization optics

4Lasers provide optical elements for polarization manipulation and controlling. Standard components include quarter-wave and half-wave three types of waveplates: zero-order compensated, air-spaced crystalline quartz waveplates, crystalline quartz and magnesium fluoride achromatic waveplates for broadband applications and zero-order, monolithic design Mid-IR (MWIR, LWIR) waveplates. Standard polarization optics also include birefringent and thin-film polarizers: Glan-type polarizers, polarizing cubes, Brewster-type thin-film and high-contrast thin-film polarizers for UV, VIS and NIR applications.

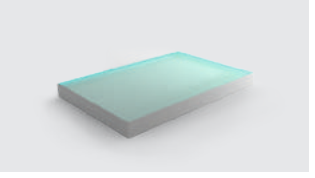
Crystalline quartz waveplates

Achromatic (broadband) waveplates

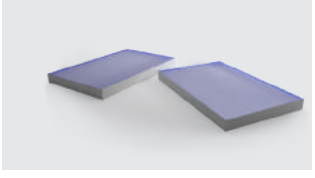
Mid-infrared (IR) waveplates

Glan-type polarizers

Polarizing cubes



Brewster-type thin-film polarizers



High contrast thin-film polarizers

Crystalline quartz waveplates

4Lasers provide mounted crystalline quartz zero-order compensated, air-spaced half-wave and quarter-wave retardance waveplates designed for a particular wavelength in the range of 257 - 1550 nm. Air-spaced construction enables these waveplates to be used for high-power applications, while zero-order design features lower temperature and wavelength dependence compared to low and multiple order waveplates.

Main features

- Zero-order compensated, air-spaced design
- True first order (FO), optically bonded on UVFS plate waveplates for high power UV application
- Wide quarter and half waveplate selection
- Mounted in ø25,4 x 6 mm black anodized metal mount
- ø18 mm clear aperture
- Antireflective coatings (R<0,15%) on each surface
- Custom size, operating wavelength, and retardation available upon request

Application examples

- Linear-to-circular polarization transformation and vice versa
- Linear polarization rotation
- Optical isolation

Standard specifications

CRYSTALINE QUARTZ WAVEPLATES	
Material	High-purity crystalline quartz
Type	Zero order (ZO) compensated, air-spaced and first order (FO), optically bonded for UV application
Available operating wavelength range	200 nm - 2200 nm
Typical retardation tolerance	<λ/300@20 °C
Clear aperture	ø18 mm
Parallelism error	<5 arcsec
Surface quality	20-10 S-D
Transmitted wavefront distortion	<λ/10@632,8 nm
Coatings	Antireflective coatings (R<0,15%) on each surface
LIDT	>12 J/cm^2@1064 nm, 10 ns (for 1064 nm waveplates)
Mount	Mounted in ø25,4 x 6 mm black anodized metal mount

Standard products

CLEAR APERTURE	RETARDATION	ORDER	TYPE	WAVELENGTH	SKU	PRICE
ø18 mm	λ/2	First order	Optically bonded	257 nm	10759	215 €
				266 nm	10750	215 €
				343 nm	10747	195 €
				355 nm	10748	195 €
		Zero order	Air-spaced	400 nm	8078	195 €
				515 nm	8079	195 €
				532 nm	8080	195 €
				780 nm	8081	195 €
				800 nm	8082	195 €
				1030 nm	8083	195 €
				1064 nm	8084	195 €
				1550 nm	8085	195 €
	λ/4	First order	Optically bonded	257 nm	15664	215 €
				266 nm	15665	215 €
				343 nm	13325	195 €
				355 nm	13611	195 €
		Zero order	Air-spaced	400 nm	8066	195 €
				515 nm	8067	195 €
				532 nm	8068	195 €
				780 nm	8069	195 €
				800 nm	8070	195 €
				1030 nm	8071	195 €
				1064 nm	8072	195 €
				1550 nm	8073	195 €

Achromatic (broadband) waveplates

4Lasers provide mounted achromatic (broadband) half-wave and quarter-wave retardance waveplates for several bands in the wavelength range of 460 nm - 1700 nm. Air-spaced construction enables to use these waveplates for high-power applications. These waveplates are ideal for multiple wavelengths and broadband operation, due to their constant retardance over a particular broad wavelength range.

Main features

- Air-spaced design
- Mounted in ø25,4 x 6 mm black anodized metal mount
- ø12 mm and ø18 mm clear aperture selection
- Broadband antireflective coatings (R<0,5%) on each surface
- Custom size, operating wavelength range and retardation available upon request

Application examples

- Linear-to-circular polarization transformation and vice versa
- Linear polarization rotation
- Optical isolation

Standard specifications

ACHROMATIC (BROADBAND) WAVEPLATES	
Material	High-purity crystalline quartz and magnesium fluoride
Type	Air-spaced
Retardation tolerance	<λ/100@20 °C
Parallelism error	<5 arcsec
Surface quality	40-20 S-D
Transmitted wavefront distortion	<λ/8@632,8 nm
Coatings	BBAR(R<0,5%) on each surface
Laser induced damage threshold	>8 J/cm²@1064 nm, 10 ns (for 650-1100 nm waveplates)
Mount	Mounted in ø25,4 x 6 mm black anodized metal mount

Standard products

RETARDATION	WAVELENGTH	CLEAR APERTURE	SKU	PRICE
λ/2	460-650 nm	ø12 mm	8107	395 €
		ø18 mm	8109	595 €
	650-1100 nm	ø12 mm	8111	395 €
		ø18 mm	8113	595 €
	1000-1700 nm	ø12 mm	8115	395 €
		ø18 mm	8117	595 €
λ/4	460-650 nm	ø12 mm	8106	395 €
		ø18 mm	8108	595 €
	650-1100 nm	ø12 mm	8110	395 €
		ø18 mm	8112	595 €
	1000-1700 nm	ø12 mm	8114	395 €
		ø18 mm	8116	595 €

Mid-infrared (MIR) waveplates

4Lasers provide unique zero-order, monolithic design mid-infrared (MWIR and LWIR) waveplates mounted in ø25,4 x 6 mm black anodized metal mount for the range of 2800 nm - 10600 nm. These waveplates are available with quarter-wave, half-wave or any other custom retardance. Each MWIR and LWIR waveplates designed for a particular wavelength in the range from 3500 nm to 10600 nm are antireflective coated, while each 2800 nm - 3000 nm waveplates are uncoated.

Main features

- Zero-order, monolithic design
- Operating wavelength selection from 2800 nm to 10600 nm
- Mounted in ø25,4 x 6 mm black anodized metal mount
- ø6 mm and ø10 mm standard clear apertures
- Custom size, operating wavelength available upon request

Application examples

- Linear-to-circular polarization transformation and vice versa
- Linear polarization rotation
- Optical isolation

Standard specifications

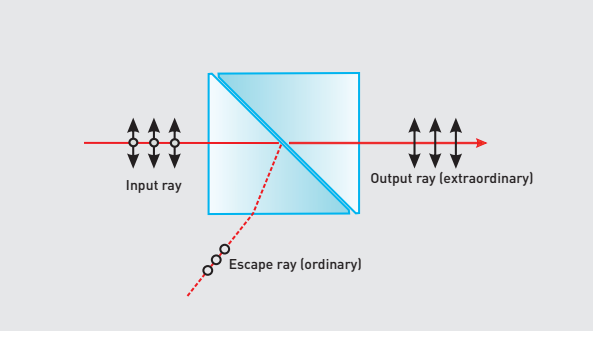
MID-IR WAVEPLATES	
Type	Zero-order, monolithic
Available operating wavelength range	2800 nm - 10600 nm
Retardation tolerance	<λ/50@20 °C
Clear aperture	ø6 mm and ø10 mm
Parallelism error	<1 arcmin
Surface quality	60-40 S-D
Coatings	Antireflective coating (R<1%) on each surface or uncoated
Laser induced damage threshold	2 J/cm^2@ 9000 nm, 10 ns (for 9000nm waveplates)
Mount	Mounted in ø25,4 x 6 mm black anodized metal mount

Standard products

CLEAR APERTURE	RETARDATION	COATINGS	WAVELENGTH	SKU	PRICE
ø10 mm	λ/2	Uncoated	3000 nm	13219	455 €
		AR coated	3500 nm	8175	455 €
			4000 nm	8177	455 €
			4500 nm	8179	455 €
			5000 nm	8181	455 €
			5500 nm	8183	455 €
			6000 nm	8185	455 €
			6500 nm	8187	455 €
			7000 nm	8189	455 €
			7500 nm	8191	1520 €
			8000 nm	8193	1520 €
			8500 nm	8195	1520 €
			9000 nm	8197	1520 €
			9500 nm	8199	1520 €
			10000 nm	19791	1520 €
			10600 nm	19793	1520 €
	λ/4	Uncoated	3000 nm	13220	455 €
		AR coated	3500 nm	8174	455 €
			4000 nm	8176	455 €
			4500 nm	8178	455 €
			5000 nm	8180	455 €
			5500 nm	8182	455 €
			6000 nm	8184	455 €
			6500 nm	8186	455 €
			7000 nm	8188	455 €
			7500 nm	8190	1520 €
			8000 nm	8192	1520 €
			8500 nm	8194	1520 €
			9000 nm	8196	1520 €
			9500 nm	8198	1520 €
			10000 nm	19790	1520 €
			10600 nm	19792	1520 €

CLEAR APERTURE	RETARDATION	COATINGS	WAVELENGTH	SKU	PRICE
ø6 mm	λ/2	AR coated	7500 nm	19893	760 €
			8000 nm	19894	760 €
			8500 nm	19895	760 €
			9000 nm	19896	760 €
			9500 nm	19897	760 €
			10000 nm	19898	760 €
			10600 nm	19899	760 €
	λ/4	AR coated	7500 nm	19901	760 €
			8000 nm	19903	760 €
			8500 nm	19904	760 €
			9000 nm	19905	760 €
			9500 nm	19908	760 €
			10000 nm	19909	760 €
			10600 nm	19910	760 €

Glan-type polarizers



4Lasers provide air-spaced Glan-Taylor and Glan-laser type polarizers fabricated from α -BBO (UV), calcite (VIS to NIR), YVO_4 (VIS to Mid-IR) birefringent crystalline material and mounted in a barrel-type black anodized aluminum mount. Glan-type polarizers are constructed to transmit only the extra-ordinary polarized beam, while ordinary polarized beam is deflected. These polarizers feature an extremely high extinction ratio over a wide wavelength range and their common applications include polarization separation, polarization cleaning, power attenuation. Glan-Taylor polarizers are designed for low and mid-power applications, while Glan-Lasers – for high-power regime due to their higher damage threshold and escape window in housing for deflected ordinary polarized beam. Single MgF_2 layer is applied onto Glan-type polarizer optical surfaces in order to noticeably maximize their broadband transmission.

Main features

- Substrate material: α-BBO, calcite and YVO_4
- Extremely high extinction ratio over a wide wavelength range
- Air-spaced configuration
- Minor transmitted beam displacement and deviation
- Single MgF_2 coating layer on every optical face for optimized broadband transmission
- Customization available upon request

Application examples

- Optical isolation
- Polarization separation
- Polarization cleaning
- Laser power attenuation

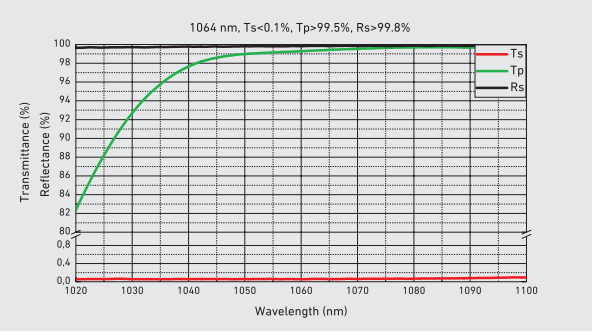
Standard specifications

Extinction ratio (transmitted beam)	α -BBO and YVO_4 polarizers: <5 x 10^{-6} Calcite polarizers: <5 x 10^{-5}
Beam deviation	<3 arcmin
Length tolerance	±0,1 mm
Parallelism error	<1 arcmin
Surface quality	20-10 S-D
Surface flatness	<λ/4@632.8 nm
Coatings	Single MgF_2 layer
LIDT	Glan-Taylor polarizers: >200 MW/cm^2 @1064 nm, 10 ns Glan-laser polarizers: >500 MW/cm^2 @1064 nm, 10 ns
Mount	Black anodized aluminum barrel-type mount

Standard products

MATERIAL	WAVELENGTH RANGE	TYPE	MOUNT DIAMETER	CLEAR APERTURE	MOUNT LENGTH	SKU	PRICE
Calcite	350-2300 nm	Glan-Laser	ø15 mm	6 mm	21 mm	7425	410 €
			ø25,4 mm	8 mm	25 mm	7426	485 €
			ø25,4 mm	10 mm	26 mm	7427	560 €
		Glan-Taylor	ø15 mm	6 mm	21 mm	7413	400 €
			ø25,4 mm	8 mm	25 mm	7414	475 €
			ø25,4 mm	10 mm	26 mm	7415	550 €
YVO_4	500-4000 nm	Glan-Laser	ø15 mm	6 mm	16 mm	7428	550 €
			ø25,4 mm	8 mm	19 mm	7429	620 €
			ø25,4 mm	10 mm	22 mm	7430	760 €
		Glan-Taylor	ø15 mm	6 mm	16 mm	7416	540 €
			ø25,4 mm	8 mm	19 mm	7417	610 €
			ø25,4 mm	10 mm	22 mm	7418	750 €
α-BBO	200-300 nm	Glan-Laser	ø15 mm	6 mm	29 mm	7419	560 €
			ø25,4 mm	8 mm	31 mm	7420	610 €
			ø25,4 mm	10 mm	31 mm	7421	710 €
	300-700 nm		ø15 mm	6 mm	25 mm	7422	550 €
			ø25,4 mm	8 mm	25 mm	7423	600 €
			ø25,4 mm	10 mm	26 mm	7424	700 €
	200-300 nm	Glan-Taylor	ø15 mm	6 mm	29 mm	7407	500 €
			ø25,4 mm	8 mm	31 mm	7408	560 €
			ø25,4 mm	10 mm	31 mm	7409	650 €
	300-700 nm		ø15 mm	6 mm	25 mm	7410	500 €
			ø25,4 mm	8 mm	25 mm	7411	560 €
			ø25,4 mm	10 mm	26 mm	7412	650 €

Polarizing cubes



4Lasers unmounted polarizing cubes are fabricated from two identical right-angle prisms with their hypotenuse faces adhered together via optical contact or epoxy glue. Polarizing cubes are designed to transmit p-polarized light with minor deviation (<3 arcmin) and deflect s-polarized light by 90° angle. Prior to cementing polarizing dielectric thin-film coating is applied onto one of the prisms hypotenuse face, while input and exit surfaces are antireflective coated for particular wavelength range. 4Lasers optically contacted polarizing cubes provide higher laser induced damage threshold, therefore are primarily used for high-power applications, while epoxy glued cubes are a cost-effective choice for low and mid-power applications. We recommend to use these elements with collimated laser beams in order to avoid beam aberrations.

Main features

- Optically contacted or epoxy glued configurations available
- Minor transmitted beam deviation (<3 arcmin)
- Antireflective coated input and output faces

Application examples

- Beam separation and combining by polarization
- Polarization separation

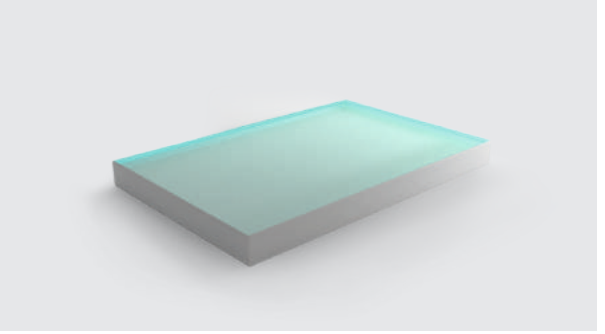
Standard specifications

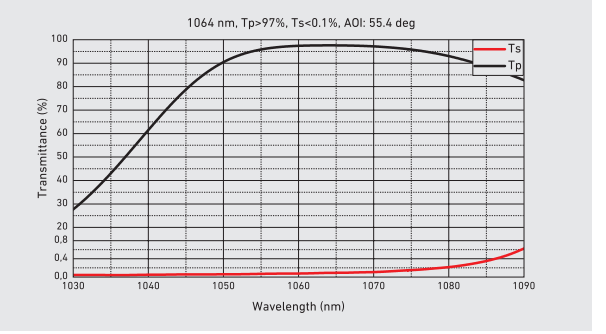
POLARIZING CUBES	
Beam deviation	<3 arcmin
Clear aperture	>85%
Face dimensions tolerance	+0/-0,2 mm
Thickness tolerance	±0,25 mm
Protective chamfers	<0,35 mm at 45°
Coatings	Hypotenuse face: polarization beamsplitting coating Input and output faces: antireflective coatings
Surface quality	40-20 S-D
Surface flatness	<λ/4@632,8 nm
Laser induced damage threshold	>15 J/cm^2@1064 nm, 10 ns (for 1025-1080 nm optically contacted cubes) >0,1 J/cm^2@532 nm, 10 ns (for 400-700 nm epoxy glued cubes)
Mount	Unmounted, available upon request

Standard products

TYPE	APPLICATION	TRANSMISSION (P-POL)	TRANSMISSION (S-POL)	WAVELENGTH RANGE	DIMENSIONS	SKU	PRICE
Epoxy glued	Low and mid-power	>92%	<0,2%	400-700 nm	6,35 x 6,35 x 6,35 mm	7442	130 €
					12,7 x 12,7 x 12,7 mm	7443	150 €
					25,4 x 25,4 x 25,4 mm	7444	175 €
Optically contacted	High-power	>96%	<0,1%	345-360 nm	6,35 x 6,35 x 6,35 mm	7439	180 €
					12,7 x 12,7 x 12,7 mm	7440	310 €
					25,4 x 25,4 x 25,4 mm	7441	500 €
		>96%	<0,1%	510-535 nm	6,35 x 6,35 x 6,35 mm	7445	180 €
					12,7 x 12,7 x 12,7 mm	7446	310 €
					25,4 x 25,4 x 25,4 mm	7447	500 €
		>92%	<0,15%	650-900 nm	6,35 x 6,35 x 6,35 mm	7448	190 €
					12,7 x 12,7 x 12,7 mm	7449	340 €
					25,4 x 25,4 x 25,4 mm	7450	530 €
		>96%	<0,1%	1025-1080 nm	6,35 x 6,35 x 6,35 mm	7451	180 €
					12,7 x 12,7 x 12,7 mm	7452	310 €
					25,4 x 25,4 x 25,4 mm	7453	500 €
				1520-1570 nm	6,35 x 6,35 x 6,35 mm	7454	180 €
					12,7 x 12,7 x 12,7 mm	7455	325 €
					25,4 x 25,4 x 25,4 mm	7456	515 €

Brewster-type thin-film polarizers





4Lasers standard Brewster-type thin-film polarizers are designed for applications, which include polarization separation. These elements provide a moderate extinction ratio Tp:Ts > 200:1 and are perfectly fit for high-power and UV applications. 4Lasers design and manufacture standard and custom Brewster type polarizers in the range of 230 nm and 2000 nm with face dimensions up to 160 mm.

Main features

- Substrates fabricated from high-quality UV grade fused silica optical glass
- Designed for most popular laser line and harmonic wavelengths
- Angle of incidence: Brewster-angle
- Typical extinction ratio Tp:Ts > 200:1
- Custom dimensions, operating wavelength available upon request

Application examples

- Polarization separation
- Optical isolation
- Polarization cleaning
- Laser power attenuation

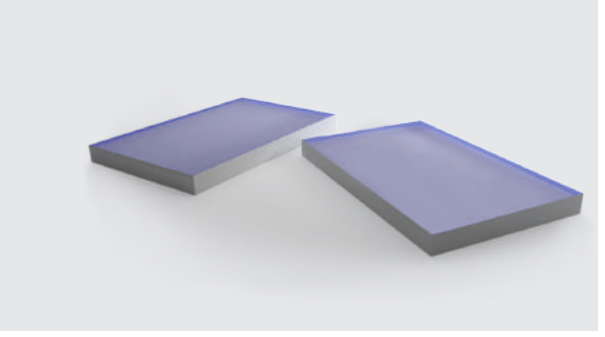
Standard specification

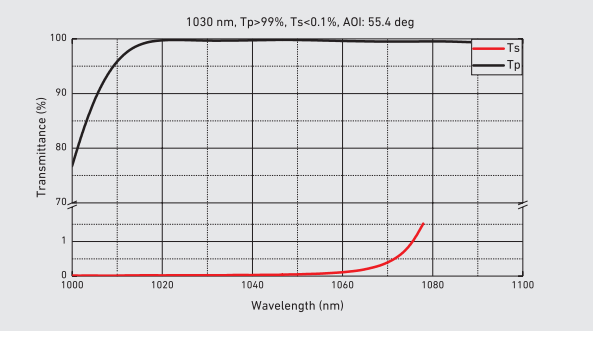
BREWSTER TYPE THIN-FILM POLARIZERS	
Material	UVFS
Clear aperture	>85%
Face dimensions tolerance	+0,0/-0,15 mm
Thickness tolerance	± 0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/8@632,8 nm for 10x20 mm; <λ/6@632,8 nm for 20 x 40 mm
Transmitted wavefront distortion	<λ/10@632,8 nm for 10x20 mm; <λ/6@632,8 nm for 20 x 40 mm
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns (for 1064 nm polarizers)
Mount	Unmounted, available upon request

Standard products

FACE DIMENSIONS	THICKNESS	TRANSMISSION (P-POL)	TRANSMISSION (S-POL)	AOI	WAVELENGTH	SKU	PRICE
10 x 20 mm	5 mm	>95%	<1%	55,4°	266 nm	9375	110 €
			<0,5%	55,4°	343 nm	9376	80 €
			<0,5%	55,4°	355 nm	9377	80 €
			<0,5%	55,4°	515 nm	9378	80 €
			<0,5%	55,4°	532 nm	9379	80 €
			<0,5%	55,4°	1030 nm	9380	80 €
			<0,5%	55,4°	1064 nm	9381	80 €
20 x 40 mm	5 mm	>95%	<1%	55,4°	266 nm	9368	275 €
			<0,5%	55,4°	343 nm	9369	135 €
			<0,5%	55,4°	355 nm	9370	135 €
			<0,5%	55,4°	515 nm	9371	135 €
			<0,5%	55,4°	532 nm	9372	135 €
			<0,5%	55,4°	1030 nm	9373	135 €
			<0,5%	55,4°	1064 nm	9374	135 €

High-contrast thin-film polarizers





4Lasers standard high contrast Brewster-type and 45° thin-film polarizers provide high extinction ratio Tp:Ts > 1000:1 thanks to the ion beam sputtered (IBS) thin-film coatings. Moreover, these polarizers are ideal for high-power levels and UV wavelength range. 4Lasers design and manufacture standard and custom Brewster type high contrast polarizers for the wavelength range between 230 nm and 2000 nm with face dimensions up to 160 mm.

Main features

- Substrates fabricated from high-quality UV grade fused silica optical glass
- Designed for most popular laser line and harmonic wavelengths
- Brewster and 45° angle of incidence selection
- Typical extinction ratio Tp:Ts > 1000:1
- Custom dimensions, operating wavelength available upon request

Application examples

- Polarization separation
- Optical isolation
- Polarization cleaning
- Laser power attenuation

Standard specifications

HIGH CONTRAST THIN-FILM POLARIZERS	
Material	UVFS
Clear aperture	>85%
Face dimensions tolerance	+0/0,15 mm
Thickness tolerance	± 0,25 mm
Parallelism error	<30 arcsec
Protective chamfers	<0,35 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/2@632,8 nm for 10x20 mm; <λ/2@632,8 nm for 20x40 mm
Transmitted wavefront distortion	<λ/10@632,8 nm for 10x20 mm; <λ/6@632,8 nm for 20 x 40 mm
Laser induced damage threshold	>12 J/cm²@1064 nm, 10 ns (for 1064 nm polarizer)
Mount	Unmounted

Standard products

EXTINCTION RATIO (TP/TS)	AOI	THICKNESS	FACE DIMENSIONS	WAVELENGTH	SKU	PRICE
>1000:1	55,4°	5 mm	20 x 40 mm	343 nm	9179	205 €
				355 nm	9180	205 €
				515 nm	9181	205 €
				532 nm	9182	205 €
				1030 nm	9183	205 €
				1064 nm	9184	205 €
			10 x 20 mm	343 nm	9185	105 €
				355 nm	9186	105 €
				525 nm	9187	105 €
				532 nm	9188	105 €
				1030 nm	9189	105 €
				1064 nm	9190	105 €
>500:1	45°	5 mm	10 x 20 mm	515 nm	28435	120 €
				532 nm	28432	120 €
				1030 nm	28429	120 €
				1064 nm	28426	120 €
			20 x 40 mm	515 nm	28434	275 €
				532 nm	28431	275 €
				1030 nm	28428	275 €
				1064 nm	28425	275 €
			25,4 mm	515 nm	28436	175 €
				532 nm	28433	175 €
				1030 nm	28430	175 €
				1064 nm	28427	175 €

Beam delivery devices

4Lasers designs and manufactures compact laser beam delivery systems, laser beam expanders, reducers, divergence compensators and laser power attenuators, which are used to increase or decrease laser beam diameter, control beam divergence, and adjust laser power.

Compact motorized beam expanders MEX

High-power motorized beam expanders MEX-HP

Variable laser beam expanders, reducers VEX

Fixed ratio laser beam expanders FEX

Motorized laser power attenuators LPA

Advanced motorized laser power attenuators LPA-A

Manual laser power attenuators LPA-M

Laser power attenuators LPA-OEM

Unpolarized beam motorized laser power attenuator LPA-U

Flat top converter FTC

Motorized polarization rotator MRO

Manual 4 axis translation stage

XY Industrial holders

Compact motorized beam expanders MEX

Motorized laser beam expanders MEX series are used to increase the laser beam diameter and adjust divergence. Standard or custom-made beam expanders feature a unique mechanical closed loop sliding-lens design ensuring high pointing stability and minimal dimensions.

These variable magnification (zoom) beam expanders and reducers are designed for required wavelength and each type of our beam expanders have motorized divergence adjustability.

Main features

- Highest beam pointing stability (< 0,1 mrad)
- All-in-one design with integrated controller
- Two lens simultaneous SMART movement assuring no mis-focus
- Absolute encoder (both lenses)
- Adjustment time <1s (all magnifications)
- Fused silica optical elements
- No homing after switching on/off
- Diffraction limited performance for all magnifications

Application examples

- Industrial laser micromachining
- Life sciences
- Research

Standard specifications

MOTORIZED BEAM EXPANDERS SPECIFICATIONS	
Adjustment	Motorized
Divergence	Adjustable
Clear input aperture	11,5 mm
Transmission	>97%
Optical element number	3 (MEX18, MEX13), 4 (MEX18-ACH)
Lens material	UVFS
Control interface	USB or RS232
Housing material	Black anodized aluminum
LIDT	3 J/cm^2 (10 ns @ 355 nm) 5 J/cm^2 (10 ns @ 532 nm) 10 J/cm^2 (10 ns @ 1064 nm)

*Custom design available

Standard products

ITEM MODEL	EXPANSION	CLEAR INPUT APERTURE	CLEAR OUTPUT APERTURE	RECOMMENDED MAX. INPUT BEAM SIZE, $1/E^2$	DIMENSIONS (H X W X L)	WAVELENGTH	POINTING STABILITY	SKU	PRICE
MEX13	1,0x - 3,0x continuous	11,5 mm	23 mm	ø7 mm - 1x ø6 mm - 3x	45 x 45 x 140 mm	343-355 nm	< 0,3 mrad	6857	2800 €
						515-532 nm	< 0,3 mrad	6856	2600 €
						1030-1064 nm	< 0,3 mrad	6855	2600 €
						343-355 + 515-532 nm	< 0,3 mrad	6928	2900 €
						515-532 + 1030-1064 nm	< 0,3 mrad	6927	2800 €
MEX18	1,0x - 8,0x continuous	11,5 mm	38 mm	ø7 mm - 1x ø5 mm - 5x ø3 mm - 8x	45 x 45 x 237 mm	343-355 nm	< 0,5 mrad	6121	3000 €
						350-800 nm	< 0,5 mrad	9235	3400 €
						515-532 nm	< 0,5 mrad	6842	2800 €
						1030-1064 nm	< 0,5 mrad	6841	2800 €
						343-355 + 515-532 nm	< 0,5 mrad	6844	3100 €
						515-532 + 1030-1064 nm	< 0,5 mrad	6843	3000 €
	1.3x - 7.5x	11,5 mm	38 mm	ø7 mm - 1x ø5 mm - 5x ø3 mm - 8x	45 x 45 x 237 mm	257-266 nm	< 0,5 mrad	12080	3400 €

Mounting options for motorized beam expanders MEX

MOUNTING OPTION	FOR BEAM HEIGHT OF	SKU	PRICE
Manual 4 axis translation stage MSTAGE	27 mm (±2 mm travel)	12571	580 €

High-power motorized beam expanders MEX-HP

High power motorized laser beam expanders MEX series are used to increase the laser beam diameter and adjust divergence. The optical design is dedicated for high power ultrafast femtosecond laser applications. These magnification (zoom) beam expanders are designed for required wavelength and each type of beam expanders has motorized divergence adjustability. Standard or custom-made beam expanders feature a unique mechanical closed loop sliding-lens design ensuring high pointing stability and minimal dimensions.

Main features

- High power optical design (up to 200 W @ 1030 nm, 500 fs, 1 Mhz)
- No internal reflections on optical elements
- Highest beam pointing stability < 0,2 mrad
- All-in-one design with an integrated controller
- Two lens simultaneous movement assuring no misfocus
- Absolute encoder (both lenses)
- Fused silica optical elements
- Diffraction limited performance for all magnifications

Application examples

- Precise laser micromachining
- High power laser beam management
- Research

Standard specifications

HIGH POWER MOTORIZED LASER BEAM EXPANDERS SPECIFICATIONS	
Adjustment	Motorized
Divergence	Adjustable
Lens material	UVFS
Transmission	>97% (MEX13-HP), >95% (MEX15-HP)
Control interface	USB or RS232
Controller	Integrated
Housing material	Black anodized aluminum
Max. laser power	Up to 200 W @ 1030 nm, 500 fs, 1 MHz
LIDT	3 J/cm^2 (10 ns @ 355nm) 5 J/cm^2 (10 ns @ 532 nm) 10 J/cm^2 (10 ns @ 1064 nm)

*Custom design available

Standard products

ITEM MODEL	EXPANSION	CLEAR INPUT APERTURE	CLEAR OUTPUT APERTURE	RECOMMENDED MAX. INPUT BEAM SIZE, 1/E²	DIMENSIONS (H X W X L)	WAVELENGTH	POINTING STABILITY	SKU	PRICE
MEX13-HP	1,0x - 3,0x continuous	11,5 mm	28 mm	ø7 mm - 1x ø6 mm - 3x	60 x 60 x 215 mm	343-355 nm	< 0,5 mrad	9242	3300 €
						343-355 nm	< 0,2 mrad	9243	3500 €
						515-532 nm	< 0,5 mrad	9240	3100 €
						515-532 nm	< 0,2 mrad	9241	3300 €
						1030-1064 nm	< 0,5 mrad	9238	3100 €
						1030-1064 nm	< 0,2 mrad	9239	3300 €
						343-355 + 515-532 nm	< 0,5 mrad	9246	3400 €
						343-355 + 515-532 nm	< 0,2 mrad	9247	3600 €
						515-532 + 1030-1064 nm	< 0,5 mrad	9244	3300 €
						515-532 + 1030-1064 nm	< 0,2 mrad	9245	3500 €
MEX15-HP	1,0x - 5,0x continuous	11,5 mm	24 mm	ø7 mm - 1x ø3,3 mm - 5x	65 x 65 x 250 nm	1030-1064 nm	< 0,2 mrad	22062	3700 €
						515-532 nm	< 0,2 mrad	22063	3700 €
						343-355 nm	< 0,2 mrad	22064	3900 €
						1030-1064 + 515-532 nm	< 0,2 mrad	22065	3900 €
						515-532 + 343-355 nm	< 0,2 mrad	22066	4000 €
						343-355 nm	< 0,5 mrad	9252	3600 €
						515-532 nm	< 0,5 mrad	9250	3400 €
						1030-1064 nm	< 0,5 mrad	9248	3400 €
						343-355 + 515-532 nm	< 0,5 mrad	9256	3700 €
						515-532 + 1030-1064 nm	< 0,5 mrad	9254	3600 €

Mounting options for high-power motorized beam expanders MEX-HP

MOUNTING OPTION	FOR BEAM HEIGHT OF	SKU	PRICE
Manual 4 axis translation stage MSTAGE-HP (Additional adapter included)	27 mm (±2 mm travel)	12571	580 €

Variable beam expanders VEX and reducers VRE

4Lasers introduces variable manual beam expanders VEX series used to increase or decrease the laser beam diameter. Standard or custom-made laser beam expanders for the UV, visible, and NIR spectral ranges feature a unique mechanical sliding-lens design, ensuring a high pointing stability and minimal dimensions. These variable magnification (zoom) beam expanders are designed for the required wavelength and each type of our beam expanders have divergence adjustability. All optical elements of beam expanders are made of fused silica with high LIDT coatings and provide stable and reliable performance even when using them with high power lasers. Large input and output apertures allow the optical beam expanders to produce diffraction limited expanded (or reduced) beams for a wide range of input beams.

Main features

- Highest beam pointing stability (< 0,5 mrad)
- Fused silica optical elements
- Grease free mechanical design
- Sliding lens design
- Diffraction limited performance for all magnifications

Application examples

- Laser micromachining
- Research

Standard specifications

VARIABLE BEAM EXPANDERS AND REDUCERS SPECIFICATIONS

Adjustment	Manual
Divergence	Adjustable
Pointing stability	<0,5 mrad, <1 mrad (VEX15-HP)
Lens material	UVFS
Transmission	>97%, >95% (VEX15-HP)
LIDT	3 J/cm^2 (10 ns @ 355nm) 5 J/cm^2 (10 ns @ 532 nm) 10 J/cm^2 (10 ns @ 1064 nm)

Standard products

ITEM MODEL	EXPANSION	CLEAR INPUT APERTURE	CLEAR OUTPUT APERTURE	RECOMMENDED MAX. INPUT BEAM SIZE, 1/E²	DESIGN	DIMENSIONS	MOUNTING OPTIONS	WAVELENGTH	SKU	PRICE
VEX13	1,0x - 3,0x continuous	11 mm	23,5 mm	ø7 mm - 1x ø5 mm - 3x	Standard	ø42 x 110 mm	M30x1 external, SM1 internal, ø38,1 mm [1,5"], T-mount (M42x0,75)	343-355 nm	4357	1180 €
								515-532 nm	6987	980 €
								1030-1064 nm	6985	980 €
								343-355 + 515-532 nm	6991	1180 €
								515-532 + 1030-1064 nm	6990	1180 €
VEX18	1,0x - 8,0x continuous	11 mm	40 mm	ø7 mm - 1x ø5,3 mm - 5x ø3,3 mm - 8x	Standard	ø53 x 203 mm	SM2, ø50,8 mm [2"]	343-355 nm	6455	1390 €
								515-532 nm	6725	1190 €
								1030-1064 nm	6992	1190 €
								343-355 + 515-532 nm	6456	1390 €
								515-532 + 1030-1064 nm	6994	1390 €
	1.3x - 7.5x continuous	11,5 mm						257- 266 nm	18932	1790 €
VEX15-HP	1,0x - 5,0x continuous	11 mm	24 mm	ø7 mm - 1x ø3,3 mm - 5x	High power	ø58 x 250 mm	T-mount, SM2, ø50,8 mm [2"]	343-355 + 515-532 nm	9279	2200 €
								515-532 + 1030-1064 nm	9273	2200 €
VRE13	0,33x - 1,0x continuous	22 mm	11 mm	ø15 mm - 0,33x ø7 mm - 1x	Standard	ø42 x 110 mm	M30x1 external, SM1 internal, ø38,1 mm [1,5"], T-mount (M42x0,75)	343-355 nm	6997	1180 €
								515-532 nm	6995	980 €
								343-355 + 515-532 nm	7000	1180 €
								515-532 + 1030-1064 nm	6999	1180 €

Mounting options for variable beam expanders VEX

MOUNTING OPTION	FOR BEAM HEIGHT OF	SKU	PRICE
Fixed post mounting set	100-125 mm (4" – 5")	9336	60 €
Fixed post mounting set	76,2 mm (3")	9337	55 €
X-Y adjustable (3 adjusters) kinematic mount with post holder, D50,8mm option	76,2 mm (3")	9348	160 €
X-Y adjustable (3 adjusters) kinematic mount with post holder, SM2 option	76,2 mm (3")	9349	170 €
X-Y adjustable (3 adjusters) kinematic mount with post holder, D50,8mm option	100-125 mm (4" – 5")	9350	165 €
X-Y adjustable (3 adjusters) kinematic mount with post holder, SM2 option	100-125 mm (4" – 5")	9351	175 €

Fixed ratio beam expanders FEX

Fixed ratio beam expanders FEX series are used to increase the laser beam diameter. The FEX model diversity covers the UV, visible and NIR spectral ranges. These compact beam expanders are designed for required wavelength and have divergence adjustability.

All optical elements of beam expanders are made of fused silica with high LIDT coatings and provide a stable and reliable performance even using them with high power lasers.

Main features

- Divergence adjustment
- Galilean optical design
- UVFS optical elements
- Grease free mechanical design
- Wide wavelength adoption - 200 nm to 2 µm

Application examples

- Laser material processing
- Medical
- Research

Standard specifications

FIXED RATIO BEAM EXPANDER SPECIFICATIONS	
Clear output aperture	23 mm
Divergence	Adjustable
Outer Diameter	30 mm
Mounting options	SM1 (male, female), ø30 mm
Transmission	>98%
LIDT	3 J/cm^2 (10 ns @ 355nm) 5 J/cm^2 (10 ns @ 532 nm) 10 J/cm^2 (10 ns @ 1064 nm)

*Custom design available

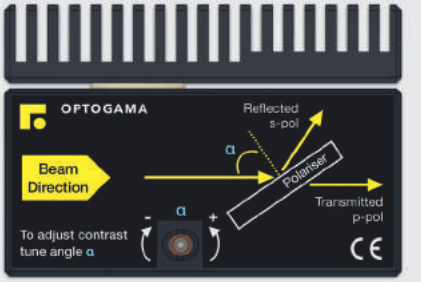
Standard products

ITEM MODEL	EXPANSION	CLEAR INPUT APERTURE	RECOMMENDED MAX. INPUT BEAM SIZE, 1/E²	CLEAR OUTPUT APERTURE	MECHANICAL LENGTH	WAVELENGTH	SKU	PRICE
FEX-2	2 x	11,5 mm	ø7 mm	23 mm	65 mm	343-355 nm	7723	199 €
						515-532 nm	7725	189 €
						1030-1064 nm	7727	189 €
						1030-1064 + 515-532 nm	11169	229 €
FEX-3	3 x	11,5 mm	ø5,3 mm	23 mm	65 mm	343-355 nm	7733	199 €
						515-532 nm	7731	189 €
						1030-1064 nm	7729	189 €
						1030-1064 + 515-532 nm	11170	229 €
FEX-4	4 x	11,5 mm	ø4 mm	23 mm	90 mm	343-355 nm	7735	199 €
						515-532 nm	7737	189 €
						1030-1064 nm	7739	189 €
						1030-1064 + 515-532 nm	11171	229 €
FEX-5	5 x	11,5 mm	ø3,2 mm	23 mm	95 mm	343-355 nm	7741	199 €
						515-532 nm	7743	189 €
						1030-1064 nm	7746	189 €
						1030-1064 + 515-532 nm	11172	229 €
FEX-8	8 x	7 mm	ø2 mm	23 mm	104 mm	343-355 nm	7749	209 €
						515-532 nm	7752	199 €
						1030-1064 nm	7754	199 €
						1030-1064 + 515-532 nm	11173	239 €

Mounting accessories for fixed ratio beam expanders FEX

RECOMMENDED ACCESSORY	FOR BEAM HEIGHT OF	SKU	PRICE
Adapter SM1 male to M30 X 1 male	-	9338	24 €
Adapter SM1 female to C-mount	-	9339	24 €
Adapter SM1 female to M30 X 1 male	-	9340	24 €
X-Y adjustable (3 adjusters) kinematic mount with post holder	50,8 mm (2")	9341	135 €
X-Y adjustable (3 adjusters) kinematic mount with post holder	76,2 - 100 mm (3" – 4")	9342	140 €

Motorized laser power attenuators LPA



4Lasers designs and manufactures motorized laser power attenuators for laser power control. LPA could be produced for use in the UV, visible, and NIR spectral ranges from 250 nm to 2000 nm. These devices feature a large clear aperture dedicated for considerable beam application.
All optical elements of these laser power attenuators are made for high LIDT and provide a stable and reliable performance even when using them with high power lasers in industrial applications.
Secondary laser beam from the laser power attenuator unit is rejected out through the output window to an external beam dump (optional) in order to avoid any thermal effects or stress in the housing of the LPA device. Exit laser beam has a 2,25 mm beam offset.

Main features

- Robust design
- Damage threshold up to 10J/cm^2 (10 ns @ 1064 nm)
- Adjustable polarizer angle ±2 deg
- Clear aperture 18 mm
- External controller included
- Intuitive software
- 175,543 steps in full rotation
- ± 0,05 % laser power accuracy
- Adjustment time <0,2 sec (min to max)

Application examples

- Laser machining
- Research
- Laser power control and attenuation

Standard specifications

MOTORIZED LASER POWER ATTENUATOR SPECIFICATIONS	
Input and output clear aperture	18 mm
Dimensions (H x W x L)	58 x 36 x 74,5 mm | 58 x 51,5 x 74,5 mm with beam dump
Control interface	USB and RS232
Controller	External

*Custom design available

Standard products

ATTENUATION RANGE	LIDT	WAVELENGTH	SKU	PRICE
0,5 - 95 %	2 J/cm² (10 ns @ 266 nm)	257 nm	9326	1550 €
		266 nm	9327	1550 €
0,2 - 96 %	3 J/cm² (10 ns @ 355nm)	343 nm	9264	1420 €
		355 nm	9263	1420 €
0,1 - 98 %	5 J/cm² (10 ns @ 532 nm)	515 nm	9262	1310 €
		532 nm	9260	1310 €
	10 J/cm² (10 ns @ 1064 nm)	1030 nm	9259	1310 €
		1064 nm	9258	1310 €

Accessories for laser power attenuators LPA

RECOMMENDED ACCESSORY	FOR BEAM HEIGHT OF	SKU	PRICE
Post mounting set	50 mm or 76 mm (2" or 3")	9343	35 €
Post mounting set	73 – 125 mm (2,9" – 5")	9344	40 €
Dedicated beam dump with protective window	-	9345	115 €

Advanced motorized laser power attenuators LPA-A

Advanced laser power attenuator LPA-A is a compact motorized device for laser power control with an integrated controller and absolute encoder. The LPA-A is produced in the UV, visible and NIR spectral ranges, from 250 nm to 2000 nm.
This device is combined with the unique mechanical design which ensures repeatability and high stability of performance.

All optical components of the LPA-A are made for high LIDT and provide a stable and reliable performance even when using them with high power lasers in industrial applications. A secondary laser beam from the laser power attenuator unit can be rejected to an external beam dump. The beam dump is used for avoiding any thermal effects or stress in the housing of the LPA-A device.

Main features

- Integrated controller
- Absolute encoder - no homing required
- High accuracy - ±0,004 deg (less than ± 0,01 % of laser power)
- Resolution - 0,002 deg, 7,4 arcsec, 0,035 mrad
- Fast adjustment - less than 0,2 sec (min to max)
- High damage threshold: up to 10J/cm^2 (10 ns @ 1064 nm)
- Adjustable polarizer angle

Application examples

- Precise laser micromachining
- Laser power control and attenuation
- Research

Standard specifications

ADVANCED VARIABLE MOTORIZED LASER POWER ATTENUATOR SPECIFICATIONS	
Input and output clear aperture	15 mm
Controller	Integrated
Dimensions (H x W x L)	86 x 47 x 58 mm
Control interface	USB or RS232

Standard products

ATTENUATION RANGE	LIDT	WAVELENGTH	SKU	PRICE
0,5 - 95 %	2 J/cm² (10 ns @ 266 nm)	257 nm	11809	1870 €
		266 nm	11810	1870 €
	5 J/cm² (10 ns @ 532 nm)	515+1030 nm	14898	1960 €
0,2 - 96 %	3 J/cm² (10 ns @ 355nm)	343 nm	11808	1730 €
		355 nm	11805	1730 €
0,1 - 98 %	5 J/cm² (10 ns @ 532 nm)	515 nm	11807	1620 €
		532 nm	11806	1620 €
	10 J/cm² (10 ns @ 1064 nm)	1030 nm	11804	1620 €
		1064 nm	11708	1620 €

Accessories for laser power attenuators LPA-A

MOUNTING OPTION	FOR BEAM HEIGHT OF	SKU	PRICE
Post mounting set	76,2 - 100 mm (3" – 4")	9346	40 €
Post mounting set	57 - 65 mm (2,2" – 2,6")	9347	35 €
Dedicated beam dump with protective window	-	9345	115 €

Manual laser power attenuators LPA-M

4Lasers designs and manufactures industrial grade manual control laser power attenuators for use in the UV, visible, and NIR spectral ranges, from 240 nm to 2000 nm.

All optical elements of these laser power attenuators are made for high LIDT and provide a stable and reliable performance even when using them with high power lasers in industrial applications.

Main features

- Industrial robust design
- Wide wavelength adoption 240 nm - 2 µm
- Cost effective

Application examples

- Laser micromachining
- Laser power attenuation
- Research

Standard specifications

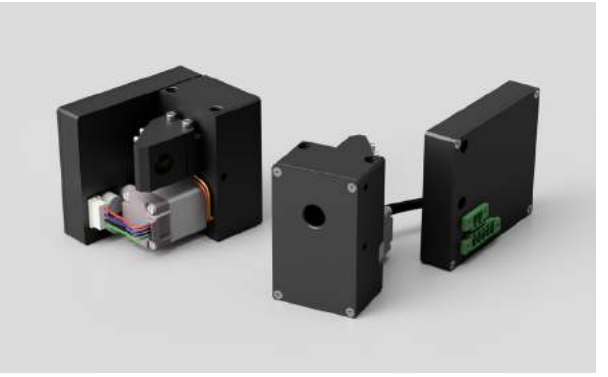
VARIABLE MANUAL LASER POWER ATTENUATOR SPECIFICATIONS	
Adjustment	Manual
Input and output clear aperture	8 mm
Dimensions (H x W x L)	57 x 72 x 105 mm

*Custom design available

Standard products

ATTENUATION RANGE	LIDT	WAVELENGTH	SKU	PRICE
0,01 - 70%	>500 MW/cm^2 10 ns @ 1064 nm	200-300 nm	18751	1700 €
		350-2300 nm	18783	1700 €
0,5-95 %	2 J/cm^2 (10 ns @ 266 nm)	257 nm	7896	850 €
		266 nm	7887	850 €
0,2-96 %	3 J/cm^2 (10 ns @ 355nm)	343 nm	7885	800 €
		355 nm	7886	800 €
0,1-98 %	5 J/cm^2 (10 ns @ 532 nm)	515 nm	7673	690 €
		532 nm	7672	690 €
	10 J/cm^2 (10 ns @ 1064 nm)	1030 nm	7671	690 €
		1064 nm	7670	690 €

OEM laser power attenuator LPA-OEM



OEM Laser power attenuator (LPA-OEM) is a compact, cost-effective motorised laser power control unit designed for integration. The LPA-OEM is produced in the UV, visible and NIR spectral ranges, from 250 nm to 2000 nm. This device is combined with the unique mechanical design which ensures repeatability and high stability of performance. All optical components of the LPA are made for high LIDT and provide stable and reliable performance even using them with high power lasers in industrial applications.

Main features

- Compact, cost-effective design
- Detachable controller for better integration
- 175,543 µsteps in full rotation
- ±10 µsteps accuracy (± 0,02 deg, less than ± 0,05 % of laser power)
- Fast adjustment - less than 0,2 sec (min to max)
- High damage threshold up to 10 J/cm^2 (10 ns @ 1064 nm)
- Adjustable polariser angle for highest contrast

Application examples

- Precise laser micromachining
- Laser power control and attenuation
- Research
- Laser integration

Standard specifications

LASER POWER ATTENUATOR LPA-OEM SPECIFICATIONS	
Input and output clear aperture	ø8 mm
Power attenuation range	<0,1% to >98%
LIDT coating	>10 [J/cm^2] (10 ns @ 1064 nm)
Close to open time	<0,2 sec
Resolution	175,543 µsteps in full rotation 21,943 µsteps in min/max rotation (0,002 deg, 7,2 arcsec, 0,035 mrad)
Accuracy	±10 µsteps (±0,02 deg, less than ±0,035%)
Dimensions (H x W x L)	58 x 36 x 57 mm LPA-OEM 58 x 50 x 67 mm LPA-OEM with beam controller 58 x 67 x 67 mm detached controller

*Custom design available

Standard products

MODEL	ATTENUATION RANGE	LIDT (COATING)	DESIGN WAVELENGTH	SKU	PRICE
LPA-OEM	0,5 - 95%	2 J/cm² (10 ns @ 266 nm)	257 nm	20051	1190 €
LPA-OEM	0,5 - 95%	2 J/cm² (10 ns @ 266 nm)	266 nm	20052	1190 €
LPA-OEM	0,2 - 96 %	3 J/cm² (10 ns @ 355 nm)	343 nm	20053	1190 €
LPA-OEM	0,2 - 96 %	3 J/cm² (10 ns @ 355 nm)	355 nm	20054	1190 €
LPA-OEM	0,1 - 98 %	5 J/cm² (10 ns @ 532 nm)	515 nm	20055	1120 €
LPA-OEM	0,1 - 98 %	5 J/cm² (10 ns @ 532 nm)	532 nm	20056	1120 €
LPA-OEM	0,5 - 95 %	5 J/cm² (10 ns @ 532 nm)	515+1030 nm	20059	1280 €
LPA-OEM	0,1 - 98 %	10 J/cm² (10 ns @ 1064 nm)	1030 nm	20057	1120 €
LPA-OEM	0,1 - 98 %	10 J/cm² (10 ns @ 1064 nm)	1064 nm	20058	1120 €

Unpolarized beam motorized laser power attenuators LPA-U

Advanced motorised laser power attenuator LPA-U is a unique device designed for unpolarised laser power control with integrated controller and absolute position encoder.
The LPA-U is produced in the UV, visible and NIR spectral ranges, from 343 nm to 2000 nm and 10,6 um. This device is combined with the unique mechanical robust design which ensures high repeatability.

All optical components of the LPA-U are made for high LIDT and provide stable and reliable performance even using them with high power lasers in industrial applications.
A secondary laser beam from laser power attenuator unit is rejected to an internal beam dump. Water-cooling is used for avoiding any thermal effects or stress in the housing of the LPA-U device.

Main features

- Designed for unpolarised laser beam
- Up to 200W of average laser power
- Beam offset compensated
- Integrated controller
- Absolute position encoder - no homing required
- High accuracy ±0,005 deg
- Robust design with water-cooling
- Clear aperture - ø12 mm
- Fast adjustment - less than 0,5 sec (min to max)
- High damage threshold: up to 10J/cm2 (10 ns @ 1064 nm)

Application examples

- Precise laser micromachining
- Laser power stabilization
- Research

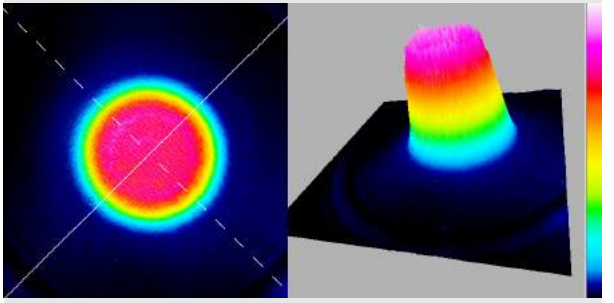
Standard specifications

UNPOLOARIZED BEAM MOTORIZED LASER POWER ATTENUATOR LPA-U SPECIFICATIONS	
Input and output clear aperture	12 mm
Controller	Integrated
Dimensions (H x W x L)	5 x 93,5 x 135 mm
Control interface	USB or RS232

Standard products

MODEL	ATTENUATION RANGE	DIMENSIONS (H x W x L)	DESIGN WAVELENGTH	SKU	PRICE
LPA-U	2 - 95%	85 x 93,5 x 135 mm	1070 nm	21710	3500 €
LPA-U	2,5 - 93%	85 x 93,5 x 135 mm	1064 nm	28839	3500 €

Flat top converter FTC



Flat top converter unit is "all in one" motorized solution for a Gaussian beam transformation to a Flat-Top (Top Hat) beam. The beam profile remains Flat-Top shape along optical axis. The device consists of quartz wave-plate, space-variant wave-plate and a high contrast polarizer. The FTC is produced in the UV, visible and NIR spectral ranges, from 250 nm to 2000 nm.

All optical components of the FTC are made for high LIDT and provide stable and reliable performance even using them with high power lasers in industrial applications.
A secondary laser beam from Flat top converter unit can be rejected to an external beam dump. The beam dump is used for avoiding any thermal effects or stress in the housing of the FTC device.

Main features

- Quick change between Gaussian and Flat-top beam
- The beam profile remains Flat-Top shape along optical axis
- Integrated controller
- Designed according your laser specs.
- Clear aperture up to 15 mm
- Quick switching time - 0.2 sec
- High damage threshold up to 10J/cm^2 (10 ns @ 1064 nm)
- Conversion efficiency up to 70% (while on Flat-Top mode)

Application examples

- Precise laser micromachining
- Life sciences
- Research

Standard specifications

FLAT TOP CONVERTER FTC SPECIFICATIONS	
Input and output clear aperture	ø15 mm (depends on waveplate)
Conversion efficiency and transmission	Up to 70 % (Flat-Top beam mode) No less than 97 % (Gaussian beam mode)
LIDT coating	>10 [J/cm^2] (10 ns @ 1064 nm)
Controller	USB and RS232
Control interface	External
Dimensions (H x W x L)	105 x 53 x 62,5 mm FTC 105 x 70 x 62,5 mm FTC with beam dump (BD-6)

*Custom design available

Standard products

MODEL	APERTURE	WAVELENGHT	ADJUSTMENT	TYPE	CONTROL INTERFACE	TYPICAL APPLICATION	SKU	PRICE
FTC	ø 6 mm	1030 nm	Motorised	DOE	USB or RS232	Flat top converter	19750	5800 €
	ø 6 mm	515 nm	Motorised	DOE	USB or RS232	Flat top converter	19751	5800 €
	ø 3 mm	1030 nm	Motorised	DOE	USB or RS232	Flat top converter	19752	4900 €
	ø 3 mm	515 nm	Motorised	DOE	USB or RS232	Flat top converter	19753	4900 €
	ø 6 mm	1064 nm	Motorised	DOE	USB or RS232	Flat top converter	19754	5800 €
	ø 3 mm	1064 nm	Motorised	DOE	USB or RS232	Flat top converter	19755	4900 €
	ø 6 mm	532 nm	Motorised	DOE	USB or RS232	Flat top converter	19756	5800 €
	ø 3 mm	532 nm	Motorised	DOE	USB or RS232	Flat top converter	19757	4900 €

Motorized polarization rotator MRO

Rotator (MRO) is a compact motorized device for laser polarization control. The MRO is produced in the UV, visible and NIR spectral ranges, from 250 nm to 2000 nm. The device has external controller.

All optical components of the MRO are made for high LIDT and provide stable and reliable performance even using them with high power lasers in industrial applications.

Main features

- Compact design
- High resolution 175543 µsteps in 360 deg rotation
- High accuracy - ±10 µsteps accuracy (± 0,02 deg)
- Clear aperture - 18 mm
- Fast adjustment - less than 0,2 sec (0 to 45 deg)

Standard specifications

SPECIFICATIONS	
Clear aperture	ø 18 mm
Standard wavelengths	257 nm; 343 nm; 355 nm; 400 nm; 515 nm; 532 nm; 800 nm; 1030 nm; 1064 nm
LIDT coating	>10 [J/cm2] (10 ns @ 1064 nm)
Close to open time (0 to 45 deg)	< 0,2 sec
Resolution	175,543 µsteps in full rotation 21,943 µsteps in 45deg rotation (0,002 deg, 7,2 arcsec, 0,035 mrad)
Accuracy	±10 µsteps (±0,02 deg)
Motor	2 phase stepper motor, 200 steps with 256 µstepping
Mechanical dimensions	37,5 x 36 x 58 mm
Controller mechanical dimensions	125 x 53 x 31 mm
Software	LPA software

Standard products

CLEAR APERTURE	CONTROL INTERFACE	WAVEPLATE	RETARDATION	LIDT	SKU	PRICE
18 mm	USB or RS232	1064 nm	L/2	10 J/cm² (10 ns@1064 nm)	19706	1090 €
		1030 nm	L/2	10 J/cm² (10 ns@1030 nm)	19572	1090 €
		532 nm	L/2	5 J/cm² (10 ns@532 nm)	19705	1090 €
		515 nm	L/2	5 J/cm² (10 ns@515 nm)	19700	1090 €
		355 nm	L/2	3 J/cm² (10 ns@355 nm)	19702	1130 €
		343 nm	L/2	3 J/cm² (10 ns@343 nm)	19701	1130 €
		266 nm	L/2	2 J/cm² (10 ns@266 nm)	19703	1130 €
		257nm	L/2	2 J/cm² (10 ns@257 nm)	19704	1130 €
		1064 nm	L/4	10 J/cm² (10 ns@1064 nm)	19708	1090 €
		1030 nm	L/4	10 J/cm² (10 ns@1030 nm)	19479	1090 €
		532 nm	L/4	5 J/cm2 (10 ns@532 nm)	19709	1090 €
		515 nm	L/4	5 J/cm² (10 ns@515 nm)	19478	1090 €
		355 nm	L/4	3 J/cm² (10 ns@355 nm)	13527	1130 €
		343 nm	L/4	3 J/cm² (10 ns@343 nm)	19477	1130 €
		266 nm	L/4	2 J/cm² (10 ns@266 nm)	19711	1130 €
		257nm	L/4	2 J/cm² (10 ns@257 nm)	19710	1130 €
		without optics	None	None	19707	990 €

Manual 4 axis translation stage

MSTAGE is an industrial mounting solution for MEX compact series beam expanders.
This 4-axis manual translation stage contains a locking mechanism preserving the aligned position. It features sapphire contact pads determining long-lasting and smooth micro screw operation.

There are four M6 x 0,25 micro screws for adjusting platform's pitch, yaw, Y and Z axis.
Two micro screws control platform's pitch and Z axis, while another two-control yaw and Y axis. All of them can be adjusted with 2 mm HEX screwdriver.

Main features

- Sapphire contact pads
- Industrial design
- 4 axis fine adjustment
- Maximum load up to 1,5 kg

Application examples

- Motorized beam expander MEX fine adjustment
- Precise alignment of optical components and other laser accessories

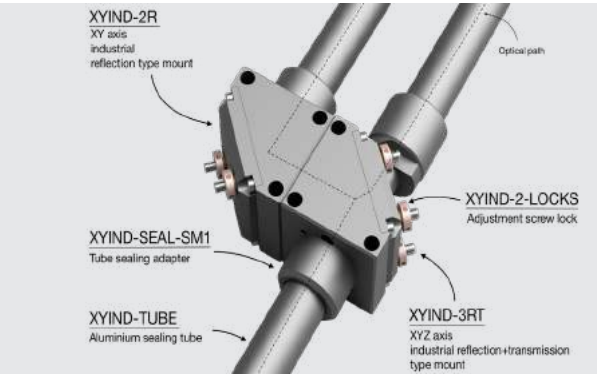
Standard specifications

SPECIFICATIONS	
Travel range	Y axis: 8 mm (±4 mm)
	Z axis: 4 mm (±2 mm)
	Yaw: ±5.5 deg
	Pitch: ±2.5 deg
Resolution	Y axis: 8 mm (±4 mm)
	Z axis: 145 µm/rev
	Yaw: 0.018 deg/rev
	Pitch: 0.010 deg/rev
Maximum load	Mounted horizontally 1.5 kg
	Mounted vertically 0.6 kg

Standard products

MODEL	DIMENSION (W X H X L)	WEIGHT	HEX SCREWDRIVER	SKU	PRICE
Mstage	75 x 28 x 100 mm	27 mm (±2 mm travel)	3mm, 2mm, 1.5 mm HEX	12571	580 €
Mstage-W	102 x 28 x 100 mm	27 mm (±2 mm travel)	3mm, 2mm, 1.5 mm HEX	29135	650 €

Industrial mirror holders



XY-IND are 2-axis and 3-axis sealed industrial kinematic mirror/splitter mounts. It combines with sealing tubes in both ends for optics and laser beam path protection from dust and environment. The mounts are easily attached together at any direction.

There are two types of holders:
- 2-axis or 3-axis Reflection type - is typically used with mirror.
- 3-axis Reflection + Transmission type - is typically used for splitting or filtering the laser beam.

Main features

- Sealed industrial design
- Reflection or Refraction +Transmission design
- Attaches together at any direction
- 3 axis fine adjustment
- Combines with sealing tubes for enclosing laser path

Application examples

- Precision optics mounting
- "Closed" optical system
- High power laser beam guiding
- Beam delivery systems

SPECIFICATIONS	
Angular range	±3,2 deg
Z axis*	±1,75 mm
Clear aperture	ø 16 mm (reflection type) ø 12 mm (transmission type)
Max. recommended beam size	ø 14 mm (reflection type) ø 10 mm (transmission type)
Max. recommended beam size 1/e2	ø 10 mm (reflection type) ø 8 mm (transmission type)
Fis	ø 25,0-25,4 mm (1,0"), 2-5 mm thickness
Angular	0,45 deg/rev 8 mrad/rev
Z axis	254 µm/rev
Adjustment microscrew	2 mm HEX
	Mounted vertically 0.6 kg

Standard products

PRODUCT	DIMENSIONS	ITEM MODEL	MATERIAL	SKU	PRICE
XYZ industrial holders	50 x 50 x 50 mm (H x W x L)	XYIND-3R-B	Black anodized aluminum	20021	149 €
		XYIND-3T-B		20022	175 €
		XYIND-3R-N	Natural anodized aluminum	29095	149 €
		XYIND-3RT-N		29096	175 €
XY industrial holders	50 x 50 x 50 mm (H x W x L)	XYIND-2R-B	Black anodized aluminum	20020	135 €
		XYIND-2R-N	Natural anodized aluminum	29094	135 €
Tube seal with o-ring	24 x 32 mm (D x L)	XYIND-SEAL-SM1-B	Black anodized aluminum	28252	19 €
		XYIND-SEAL-SM1-N	Natural anodized aluminum	29092	19 €
	40 x 32 mm (D x L)	XYIND-TUBE-JOINT-B	Black anodized aluminum	28253	27 €
		XYIND-TUBE-JOINT-N	Natural anodized aluminum	29093	27 €
Holder Post	85 x 50 x 50 mm (H x W x L)	XYIND-L-H85-C110	Black anodized aluminum	29084	49 €
	135 x 50 x 50 mm (H x W x L)	XYIND-V-H135		29085	Request
Holder locking nuts (3 pcs)	12,5 x 3,8 mm (D xT)	XYIND-3-LOCKS	Bronze	28251	25.5 €
Holder locking nuts (2 pcs)	12,5 x 3,8 mm (D xT)	XYIND-2-LOCKS		28250	16.9 €
Aluminum sealing tube	22 x 100 mm (D x L)	XYIND-TUBE-N-1	Natural anodized aluminum	28254	18 €
	22 x 0 ... 50 mm (D x L)	XYIND-TUBE-N-C05		28255	18 €
	22 x 50 ... 100 mm (D x L)	XYIND-TUBE-N-C051		28256	28 €
	22 x 50 mm (D x L)	XYIND-TUBE-B-05	Black anodized aluminum	28257	25 €
	22 x 0 ... 25 mm (D x L)	XYIND-TUBE-B-C025		28258	25 €
	22 x 25 ... 50 mm (D x L)	XYIND-TUBE-B-C02505		28259	35 €

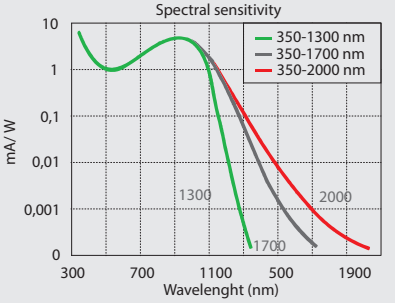
Laser accessories

4Lasers offers a variety of laser accessories designed and dedicated to enhancing your capabilities to visualize, guide and to monitor near infrared (NIR) and ultraviolet (UV) laser beams, parasitic reflections or losses in the fibers.

Infrared (IR) viewers

UV-NIR laser beam visualizers

Infrared (IR) viewers



Infrared (IR) viewers are used to observe, register, and record both indirect and direct radiation of IR lasers, light emitting diodes (LED's), dye and other IR-sources. It is ideal for IR-laser beam alignment and inspection, optical fiber alignment, telecommunications, solar panel inspection, photo processing, surveillance and investigation in botany, biophysics, medicine, forensics and art restoration, infrared microscopy, fluorescence etc. High performance image conversion infrared (IR) viewers based on high-grade image converter are designed to observe indirect radiation of infrared laser, light emitting diodes (LED), dye and other IR-sources in 350–2000 nm spectral range. (IR) Infrared viewer is based on a first-generation high-grade image converter that has an electro-static focusing system, photocathode S-1+ with an increased concentration of oxygen and screen of type P-20 with the maximum of luminescence at 550 nm. Infrared viewer focus emitted or reflected light from a chosen object into the image tube where the electron image is generated. When powered (with a battery or power supply) the 16-18 kV voltage is generated to accelerate the electron image towards the phosphor screen at the output. The fluorescent green light output (550 nm) is observed via an adjustable eyepiece lens.

Main features

- Spectral region 350-2000 nm
- Resolution 60 Lp/mm
- Hand-held / post mounted
- Up to 50 hours battery life
- Pulsed and CW light detection

Application examples

- Location and alignment of Nd: YAG Yb:YAG, Yb:KGW, Ti:Sapphire and other IR lasers
- Identification of stray IR reflectations
- Observation of GaAs laser diodes, IR LED's, dye and other IR-sources
- Forensic analysis on inks, pigments

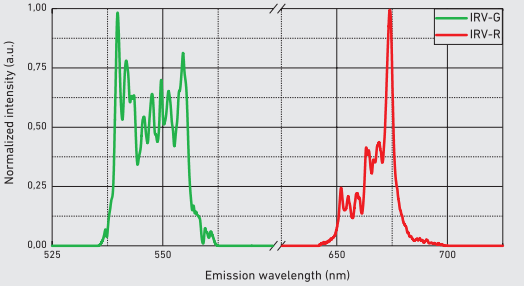
Specifications

IR-VIEWERS ABRIS M SERIES SPECIFICATIONS	
Resolution (centre)	60 Lp/mm
Working distance of lens	12,5 (+/-0,2) mm
Battery	50 hours
Non-uniformity of screen	< 20 %
Non-uniformity of response	< 15 %
Distortion of image	<18 %
Battery life (continuous)	35 hours
External power supply	5V USB
Weight	0,4 kg
Dimensions	184 x 153 x 51 mm
Temperature range	-10 °C ... 40 °C
Tripod or handle connection	R"1/4"

Standard products

FIELD OF VIEW	MAGNIFICATION	OBJECTIVE LENS	ADJUSTABLE IRIS	FOCUS	SPECTRAL SENSITIVITY	SKU	PRICE
					350-1300 nm	7654	2000 €
40°	1X	F1,4/25 mm	Included	0,15m (0,05m) to inf, (with distance ring)	350-1700 nm	7404	2100 €
					350-2000 nm	7655	2200 €
					350-1300 nm	7656	2100 €
20°	2X	F1,8/50 mm	Included	0,5m (0,15m) to inf, (with distance ring)	350-1700 nm	7657	2200 €
					350-2000 nm	7658	2300 €

UV-NIR laser beam visualizers



Laser beam visualizers are designed to detect UV and IR both CW and pulsed laser light radiation.
These visualizers are fabricated from aluminum with an organic polycrystal photosensitive region, which enables easy location of UV-VIS-NIR light beams and focal points. As it is not necessary to charge the active region both CW and pulsed laser light will be detected even in darkened room conditions.

Main features

- Wavelength detection from UV to NIR
- Suitable for CW and pulsed laser light
- High sensitivity to laser radiation – 0,1 mW/mm^2
- Damage threshold for pulsed laser – 1 J/cm^2, 10 ns
- Both sides are active

Application examples

- Laser alignment
- Research

Standard products

CLEAR APERTURE	ITEM MODEL	DETECTION SPECTRAL RANGE	EMISSION COLOR	THRESHOLD SENSITIVITY	SKU	PRICE
35 mm	IRV-R-1	190-1090 + 1470-1600 nm	Red	0,01 W/cm^2	7662	89 €
	IRV-G-1	880-1070 nm	Green	0,02 W/cm^2	7661	75 €

Notes

General Terms and Conditions of Sale

Orders may be placed by regular mail, e-mail or fax to:

Optogama
Mokslininku str. 6B
LT-08412, Vilnius, LITHUANIA

Phone: +370 5 219 4884
Fax: +370 5 219 4883
E-mail: sales@4Lasers.com

4Lasers is a division and a registered brand name of Optogama company.

1. Prices and payment

All price quotations are subject to confirmation and are non-binding.
Unless otherwise agreed to by Optogama in writing, and all prices for the sale of Product are stated in and to be paid in € (Euro).
For the orders below 200 € additional documentation and handling fee may be applied.
All payments are due and payable in thirty (30) days from date of invoice.
Optogama reserves the right to require alternative payment terms, including without limitation letter of credit or payment in advance.
Payments not made by the due date shall be subject to a late payment charge of the lesser of 0,2 % per day or the maximum rate permitted by law.
Bank fees associated with payment should be paid by the Buyer.
Payment can be made by wire transfer or credit card.

Wire transfer details:

Account number (IBAN): LT88 7044 0600 0802 0123
Bank name:
AB SEB Bankas, address: Konstitucijos Ave. 12, LT-01103 Vilnius, LITHUANIA
SWIFT Code: CBVI LT 2X
Beneficiary:
Optogama UAB, address: Mokslininku str. 6B, LT-08412 Vilnius, LITHUANIA

Payment using PayPal, credit, or debit card:

Your payment will be processed through PayPal payment system. PayPal allows you to make payments using a variety of methods including: PayPal Cash or PayPal Cash Plus account balance, a bank account, PayPal Credit, debit or credit cards, and rewards balance.
Please request Proforma Invoice for advanced payment. PayPal payment fee: 4% from total order amount + delivery costs.

2. Delivery and delays

Delivery dates noted on the Order Confirmation are subject to reasonable adjustment. The acceptance of shipment by a common carrier or by any licensed public truckman shall constitute proper delivery.

In case Optogama is unable to deliver ordered goods in time, Optogama shall notify buyer of this and at the same time, if possible, provide buyer with information on expected delivery date.

Optogama shall not be responsible for any loss suffered by buyer, including loss on operations, loss of profits or other indirect losses as a result of the delay in delivery, and consequently Optogama shall not compensate buyer for any of such loss.

Optogama reserves the right to deliver Products on DAP (Incoterms 2010) basis by DHL, UPS, TNT, FedEx or other forwarders and request to cover delivery charges by the Buyer.

3. Limited warranty and liability

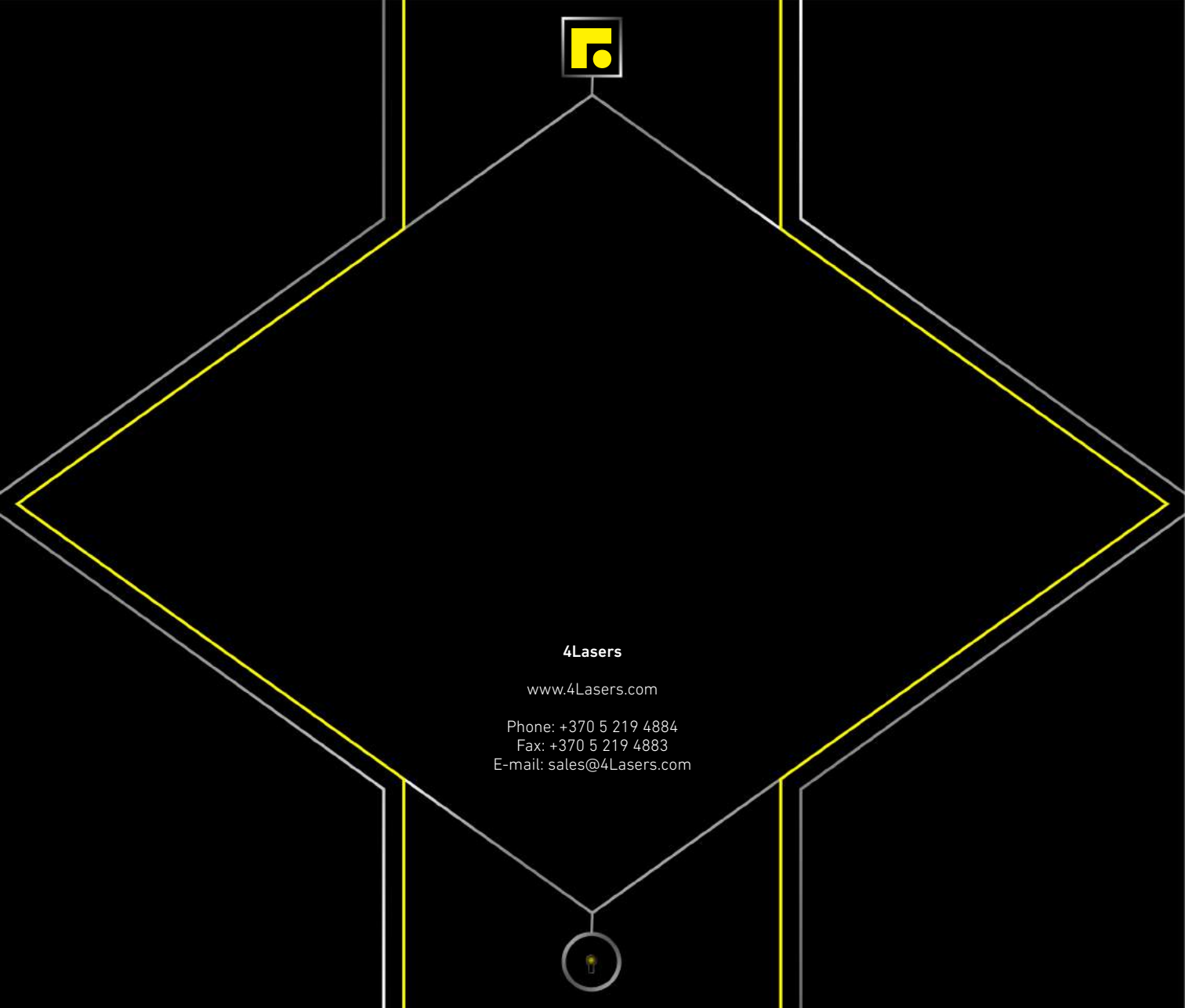
All products are guaranteed to be free from defects. Claims are accepted for a period of three months after delivery. We do not assume liability for installation, labor, or consequential damages.

Optogama shall not be liable for any defects or losses suffered by buyer, including loss on operations, loss of profits or other indirect losses as a result of the defects, and consequently Optogama shall not compensate buyer for any of such loss.

Consequently, Optogama shall have no liability for any personal injury, property damage or other loss based on the use of the product in combination with or integrated into any other instrument or device. However, if Optogama is held liable, whether directly or indirectly, for any loss or damage arising under this limited warranty or otherwise, regardless of cause or origin, Optogama maximum liability shall not in any case exceed the purchase price of the product which shall be the complete and exclusive remedy against Optogama.

4. Product return or repair

Buyer will notify Optogama about the occurrence of defective or non-operational Product and request a Return Authorization Number (RMA) from Optogama for the items Buyer would like to return for repair or replacement by email. This RMA number is to be used for all correspondence and shipping documents that relate to the Product.
Buyer will ship the defective or non-operational Product to Optogama. Buyer is responsible for shipping cost.
Upon receipt of the returned Product, Optogama will test the Product to verify the defective status of the component within the terms of the Limited Warranty and communicate such results to Buyer.
Optogama will either send a repaired or replacement Product after verifying that the Product returned under the RMA number is in fact defective within the terms of the Limited Warranty. Optogama is responsible for shipping costs of replacement Product to the Buyer.



4Lasers

www.4Lasers.com

Phone: +370 5 219 4884
Fax: +370 5 219 4883
E-mail: sales@4Lasers.com