

2024

# 友思特 激光器配件系列 产品手册



Beam  
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激光器配件

光束传输装置



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Compact motorized laser beam expanders MEX



High-power motorized beam expanders MEX-HP



Vertical motorized laser beam expander MEX-V



Variable beam expanders VEX and reducers VRE



Fixed ratio laser beam expanders FEX



Motorized laser power attenuators LPA



Manual laser power attenuators LPA-M



Unpolarized beam motorized laser power attenuator LPA-U



Flat top converter FTC



Motorized polarization rotator MRO



# 紧凑型电动激光扩束器 MEX

## 主要特点

- 最高的光束指向稳定性 ( $< 0.3 \text{ mrad}$ )
- 一体化设计, 集成控制器
- 两个镜头同步智能移动, 确保无误焦
- 绝对编码器 (两个镜头)
- 调整时间  $< 1 \text{ s}$  (所有放大倍率)
- 熔融石英光学元件
- 打开/关闭后无需归位
- 所有放大倍数具有衍射极限性能

## 应用案例

- 工业激光微加工
- 生命科学
- 研究

MEX-V2系列电动激光扩束器用于增加激光束直径和调节发散角。标准或定制光束扩展器采用独特的机械闭环滑动透镜设计, 确保高指向稳定性和最小尺寸。改进的镜头移动速度和指向稳定性确保了更好的控制质量。这些可变放大 (变焦) 光束扩展器和减速器是专为所需波长而设计的, 我们的每种类型的光束扩展器都具有电动发散角调节功能。

参数	
调整方式	自动
发散角	可调
输入孔径	11,5 mm
透射率	$> 97\%$
光学元件数量	3 (MEX13, MEX18), 4 (MEX18-ACH)
镜片材质	UVFS
控制接口	USB or RS232
外壳材料	黑色阳极氧化铝
LIDT	3 J/cm <sup>2</sup> (10 ns @ 355 nm) 5 J/cm <sup>2</sup> (10 ns @ 532 nm) 10 J/cm <sup>2</sup> (10 ns @ 1064 nm)

\*提供定制设计

## 标准产品

型号	放大倍数	输入通光孔径	输出通光孔径	推荐最大输出通光直径 (1/E2)	尺寸 (H X W X L)	设计波长	指向稳定性	货号编码	
MEX13	1.0x - 3.0x continuous	11.5 mm	23 mm	ø7 mm (1x) - ø6 mm (3x)	45 x 45 x 140 mm	1030-1064 nm	<0,5 mrad	6825	
						515-532 nm		6833	
						343-355 nm		6838	
						1030-1064 + 515-532 nm		6836	
						515-532 + 343-355 nm		6131	
						760-840 nm		31223	
						390-410 nm		31224	
						400 + 800 nm		31225	
						1030-1064 nm		6855	
						515-532 nm		6856	
						343-355 nm		6857	
						1030-1064 + 515-532 nm		<0,2 mrad	6927
						515-532 + 343-355 nm		6928	
						760-840 nm		31226	
						390-410 nm		31227	
						400 + 800 nm		31228	
						1030-1064 nm		6841	
						515-532 nm		6842	
343-355 nm	6121								
1030-1064 + 515-532 nm	<0,5 mrad	6843							
515-532 + 343-355 nm	6844								
760-840 nm	31229								
390-410 nm	31230								
400 + 800 nm	31231								
1030-1064 nm	31232								
515-532 nm	31233								
343-355 nm	31234								
1030-1064 + 515-532 nm	<0,2 mrad	31235							
515-532 + 343-355 nm	31236								
760-840 nm	31237								
390-410 nm	31238								
400 + 800 nm	31239								
MEX18-ACH	1.0x - 8.0x continuous	11.5 mm	38 mm	ø7 mm (1x) - ø5mm (5x) mm - ø3 mm (8x)	45 x 45 x 237 mm	300-750 nm	<0,5 mrad	9235	

## 电动扩束器MEX的安装附件选项

安装选项	光束高度	货号编码
手动 4 轴平移台 M-STAGE	27 mm (±2 mm travel)	12571



# 新型紧凑型电动激光 扩束器MEX-V2

## 主要性能

- 最高波束指向稳定性 (<0,1 mrad)
- 一体化设计, 集成控制器
- 两个镜头同步智能移动, 确保不会出现失焦
- 绝对编码器 (两个镜头)
- 调整时间<0.7秒 (所有放大倍数)
- 熔融二氧化硅光学元件
- 打开/关闭后无需归位
- 所有放大倍数具有衍射极限性能
- 远程控制改变聚焦光束光斑大小及其在Z轴上的位置

## 新版更新:

- 镜头移动速度快30%, 更稳定 (< 0.7秒)
- 针对全天连续工作使用情况进行了优化
- 更优的指向稳定性<0.1 mrad或<0.3 mrad
- 重新设计的具有反极性和过电流保护的控制器

## 应用案例

- 全天候工业激光微加工
- 生命科学
- 科研

MEX-V2系列电动激光扩束器用于增加激光束直径和调节发散角。标准或定制光束扩展器采用独特的机械闭环滑动透镜设计, 确保高指向稳定性和最小尺寸。改进的镜头移动速度和指向稳定性确保了更好的控制质量。这些可变放大 (变焦) 光束扩展器和减速器是专为所需波长而设计的, 我们的每种类型的光束扩展器都具有电动发散角调节功能。

## 产品包装包含

- 电动激光扩束器MEX-V2
- 带软件 and 手册的USB工具
- 电源DC 12V
- USB (1.5米) 线缆

## 标准产品

产品型号	扩束倍率	通光输入孔径	通光输出孔径	建议的最大输入光束直径 (1/E2)	尺寸 (H X W X L)	设计波长	指向稳定性	货号编码
MEX13-V2	1.0x - 3.0x continuous	11,5 mm	23 mm	ø7 mm (1x) - ø6 mm (3x)	45 x 45 x 140 mm	1030-1064 nm	<0,3 mrad	29283
						515-532 nm		29284
						343-355 nm		29285
						1030-1064 + 515-532 nm		29286
						515-532 + 343-355 nm		29287
						760-840 nm		31274
						390-410 nm		31275
						400 + 800 nm		31276
						1030-1064 nm		29288
						515-532 nm		29289
						343-355 nm		29290
						1030-1064 + 515-532 nm		29291
						515-532 + 343-355 nm		29292
						760-840 nm		31277
390-410 nm	31278							
400 + 800 nm	31279							
MEX18-V2	1.0x - 8.0x continuous	11,5 mm	38 mm	ø7 mm (1x) - ø5mm (5x) mm - ø3 mm (8x)	45 x 45 x 237 mm	1030-1064 nm	<0,3 mrad	29293
						515-532 nm		29294
						343-355 nm		29295
						1030-1064 + 515-532 nm		29297
						515-532 + 343-355 nm		29298
						760-840 nm		31280
						390-410 nm		31281
						400 + 800 nm		31282
						1030-1064 nm		31284
						515-532 nm		31285
						343-355 nm		31286
						1030-1064 + 515-532 nm		31287
						515-532 + 343-355 nm		31288
						760-840 nm		31289
390-410 nm	31290							
400 + 800 nm	31291							
MEX18-ACH-V2	1.0x - 8.0x continuous	11,5 mm	38 mm	ø7 mm (1x) - ø5mm (5x) mm - ø3 mm (8x)	45 x 45 x 237 mm	350-800 nm	<0,3 mrad	31283

## 电动扩束器MEX的安装附件选项

MOUNTING OPTION	FOR BEAM HEIGHT OF	货号编码
Manual 4 axis translation stage M-STAGE	27 mm (±2 mm travel)	12571



# 高功率电动扩束器 MEX-HP

## 主要特点

- 高功率光学设计（高达 200 W @ 1030 nm、500 fs、1 MHz）
- 光学元件无内反射
- 最高光束指向稳定性 < 0.2 mrad
- 具有集成控制器的一体化设计
- 两镜头同时移动，确保无误差
- 绝对编码器（两个镜头）
- 熔融石英光学元件
- 所有放大倍数具有衍射极限性能

## 应用

- 精准激光微加工
- 高功率激光束控制
- 科研

高功率电动激光扩束器MEX系列用于增加激光束直径和调节发散度。该光学设计专用于高功率超快飞秒激光应用。这些放大（变焦）扩束器专为所需波长而设计，每种类型的扩束器都具有电动发散可调性。标准或定制扩束器采用独特的机械闭环滑动透镜设计，确保高指向稳定性和最小尺寸。

参数	
调整方式	自动
发散角	可调
镜片材质	UVFS
透射率	>97% (MEX13-HP), >95% (MEX15-HP)
控制接口	USB or RS232
控制器	Integrated
外壳材质	Black anodized aluminum
最大激光功率	Up to 200 W @ 1030 nm, 500 fs, 1 MHz
LIDT	3 J/cm <sup>2</sup> (10 ns @ 355nm) 5 J/cm <sup>2</sup> (10 ns @ 532 nm) 10 J/cm <sup>2</sup> (10 ns @ 1064 nm)

\*提供定制设计

## 标准产品

型号	放大倍数	通光输入孔径	通光输出孔径	建议最大输入光束直径 (1/E2)	尺寸 (H X W X L)	设计波长	指向稳定性	货号编码	
MEX13-HP	1.0x - 3.0x continuous	11,5 mm	28 mm	ø7 mm (1x) - ø6 mm (3x)	60 x 60 x 207 mm	1030-1064 nm	<0,5 mrad	9238	
						515-532 nm		9240	
						343-355 nm		9242	
						1030-1064 + 515-532 nm		9244	
						515-532 + 343-355 nm		9246	
						257-266 nm		31243	
						760-840 nm		31240	
						390-410 nm		31241	
						400 + 800 nm		31242	
						1030-1064 nm		9239	
						515-532 nm		9241	
						343-355 nm		9243	
						1030-1064 + 515-532 nm		9245	
						515-532 + 343-355 nm		<0,2 mrad	9247
						257-266 nm		31244	
						760-840 nm		31245	
						390-410 nm		31246	
						400 + 800 nm		31247	
MEX15-HP	1.0x - 5.0x continuous	11,5 mm	24 mm	ø7 mm (1x) - ø3,3 mm (5x)	65 x 65 x 250 mm	1030-1064 nm	<0,5 mrad	9248	
						515-532 nm		9250	
						343-355 nm		9252	
						1030-1064 + 515-532 nm		9254	
						515-532 + 343-355 nm		9256	
						257-266 nm		31251	
						760-840 nm		31248	
						390-410 nm		31249	
						400 + 800 nm		31250	
						1030-1064 nm		22062	
						515-532 nm		22063	
						343-355 nm		22064	
						1030-1064 + 515-532 nm		22065	
						515-532 + 343-355 nm		<0,2 mrad	22066
						257-266 nm		31252	
						760-840 nm		31253	
						390-410 nm		31254	
						400 + 800 nm		31255	

## 高功率电动扩束器MEX-HP的安装附件选项

安装选项	光束高度	货号编码
Manual 4 axis translation stage M-STAGE-W	27 mm (±2 mm travel)	29135



# 高功率电动扩束器 MEX-HP-V2

## 主要特点

- 高功率光学设计 (高达 200 W @ 1030 nm、500 fs、1 Mhz)
- 光学元件无内反射
- 具有集成控制器的一体化设计
- 两镜头同时移动, 确保不失焦
- 绝对编码器 (两个镜头)
- 熔融石英光学元件
- 调整时间 <0.7 s (所有放大倍率)
- 所有放大倍数具有衍射极限性能
- 远程控制改变聚焦光束光斑大小及其在Z轴上的位置

## 新版更新

- 镜头移动速度快30%, 更稳定 (<0.7s)
- 针对全天连续工作使用情况进行了优化
- 更优的指向稳定性<0.1 mrad或<0.3 mrad
- 重新设计的具有反极性和过电流保护的控制器

## 应用案例

- 全天候工业激光微加工
- 精密激光微加工
- 高功率激光光束控制
- 科研

高功率电动激光扩束镜MEX-HP-V2系列用于增加激光束直径并调节发散度。该光学设计专用于高功率超快飞秒激光应用。改进的镜头移动速度和指向稳定性确保更好的控制质量。这些放大(变焦)扩束器专为所需波长而设计, 我们的每种类型的扩束器都具有电动发散可调性。标准或定制扩束镜采用独特的机械闭环滑动透镜设计, 确保高指向稳定性和最小尺寸。

## 产品包括:

- 电动激光扩束镜MEX-HP
- 带有软件和手册的 USB 盘
- 电源 DC 12V
- USB (1.5 m) 线缆

## 标准产品

型号	放大倍数	透光输入孔径	透光输出孔径	建议最大输入光束直径 (1/E2)	尺寸 (H X W X L)	设计波长	指向稳定性	货号编码							
MEX13-HP-V2	1.0x - 3.0x continuous	11.5 mm	28 mm	ø7 mm (1x) - ø6 mm (3x)	60 x 60 x 207 mm	1030-1064 nm	<0,5 mrad	31007							
						515-532 nm		31011							
						343-355 nm		31015							
						1030-1064 + 515-532 nm		31009							
						515-532 + 343-355 nm		31013							
						257-266 nm		31258							
						760-840 nm		31259							
						390-410 nm		31260							
						400 + 800 nm		31261							
						1030-1064 nm		31006							
						515-532 nm		31010							
						343-355 nm		31014							
						1030-1064 + 515-532 nm		31008							
						515-532 + 343-355 nm		31012							
						257-266 nm		31262							
						760-840 nm		31263							
						390-410 nm		31264							
						400 + 800 nm		31265							
						MEX15-HP-V2		1.0x - 5.0x continuous	11.5 mm	24 mm	ø7 mm (1x) - ø3,3 mm (5x)	65 x 65 x 250 mm	1030-1064 nm	<0,5 mrad	31017
													515-532 nm		31021
343-355 nm	31025														
1030-1064 + 515-532 nm	31019														
515-532 + 343-355 nm	31023														
257-266 nm	31266														
760-840 nm	31267														
390-410 nm	31268														
400 + 800 nm	31269														
1030-1064 nm	31016														
515-532 nm	31020														
343-355 nm	31024														
1030-1064 + 515-532 nm	31018														
515-532 + 343-355 nm	31022														
257-266 nm	31270														
760-840 nm	31271														
390-410 nm	31272														
400 + 800 nm	31273														

## 高功率电动扩束器MEX-HP的安装附件选项

安装选项	光束高度	货号编码
Manual 4 axis translation stage M-STAGE-W	27 mm (±2 mm travel)	29135



# 立式电动激光扩束器 MEX-V

## 主要特点

- 高功率光学设计 (高达 200 W @ 1030 nm、500 fs、1 Mhz)
- 光学元件无内反射
- 高光束指向稳定性 <0.2 mrad
- 一体化设计, 集成控制器
- 两镜头同时移动, 确保不失焦
- 绝对编码器 (两个镜头)
- 调整时间 <4 s (所有放大倍率)
- 熔融石英光学元件
- 所有放大倍数具有衍射极限性能
- 无安装限制

## 应用案例

- 精准激光微加工
- 高功率激光光束控制
- 科研

立式电动激光扩束镜MEX-V系列用于增加激光束直径和调节发散度。该光学设计专用于高功率超快飞秒激光应用。更慢、更稳定的镜头控制结合了高功率型号的优点和垂直安装的能力以实现更强大的功能。这些放大(变焦)扩束器专为所需波长而设计, 我们的每种类型的扩束器都具有电动发散可调性。标准或定制扩束镜采用独特的机械闭环滑动透镜设计, 确保高指向稳定性和最小尺寸。

## 产品包括

- 电动激光扩束镜MEX-V
- 带有软件和手册的 USB 盘
- 电源 DC 12V
- USB (1.5 m) 线缆

## 标准产品

型号	放大倍数	通光输入孔径	通光输出孔径	建议最大输入光束直径 (1/E2)	尺寸 (H X W X L)	设计波长	指向稳定性	货号编码	
MEX15-V	1.0x - 5.0x continuous	11 mm	24 mm	ø7 mm (1x) - ø3.3 mm (5x)	80 x 80 x 245 mm	1030-1064 nm	<0.5 mrad	31165	
						515-532 nm		31167	
						343-355 nm		31169	
						1030-1064 + 515-532 nm		31166	
						515-532 + 343-355 nm		31168	
						257-266 nm		31257	
						760-840 nm		31170	
						390-410 nm		31171	
						400 + 800 nm		31172	
						1030-1064 nm		31157	
						515-532 nm		31159	
						343-355 nm		31161	
						1030-1064 + 515-532 nm		31158	
						515-532 + 343-355 nm		<0.2 mrad	31160
						257-266 nm		31256	
						760-840 nm		31162	
						390-410 nm		31163	
						400 + 800 nm		31164	



# Variable beam expanders VEX and reducers VRE

## 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

Optogama 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.

## 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 <sup>2</sup> (10 ns @ 355nm) 5 J/cm <sup>2</sup> (10 ns @ 532 nm) 10 J/cm <sup>2</sup> (10 ns @ 1064 nm)

## Standard products

ITEM MODEL	EXPANSION	CLEAR INPUT APERTURE	CLEAR OUTPUT APERTURE	DESIGN	RECOMMENDED MAX INPUT BEAM DIAMETER (1/E2)	MOUNTING OPTIONS	DIMENSIONS	WAVELENGTH	SKU
VEX13	1.0x - 3.0x continuous	11 mm	23,5 mm	Standard	ø7 mm (1x) - ø5 mm (3x)	M30x1 external, SM1 internal, ø38.1 mm [1.5"], T-mount (M42x0.75)	ø42 x 110 mm	1030-1064 nm	6985
								515-532 nm	6987
								343-355 nm	4357
								1030-1064 + 515-532 nm	6990
VRE13	0.33x - 1.0x continuous	22 mm	11 mm	Standard	ø15 mm (0,33x) - ø7 mm (1x)	M30x1 external, SM1 internal, ø38.1 mm [1.5"], T-mount (M42x0.75)	ø42 x 110 mm	515-532 + 343-355 nm	6991
								1030-1064 nm	31295
								515-532 nm	6995
								343-355 nm	6997
VEX18	1.0x - 8.0x continuous	11 mm	40 mm	Standard	ø7 mm (1x) - ø5,3 mm (5x) - ø3,3 mm (8x)	SM2, ø50,8 mm [2"]	ø53 x 203 mm	1030-1064 + 515-532 nm	6999
								515-532 + 343-355 nm	7000
								1030-1064 nm	6992
								515-532 nm	6725
VRE18	0.12x - 1.0x continuous	40 mm	11 mm	Standard	ø26 mm (0,33x) - ø7 mm (1x)	SM2, ø50,8 mm [2"]	ø53 x 203 mm	343-355 nm	6455
								1030-1064 + 515-532 nm	6994
								515-532 + 343-355 nm	6456
								1030-1064 nm	31298
VEX15-HP	1.0x - 5.0x continuous	11 mm	24 mm	High power	ø7 mm (1x) - ø3,3 mm (5x)	T-mount, SM2, ø50,8 mm [2"]	ø58 x 250 mm	515-532 nm	31299
								343-355 nm	31300
								1030-1064 + 515-532 nm	31301
								515-532 + 343-355 nm	31302
VEX15-HP	1.0x - 5.0x continuous	11 mm	24 mm	High power	ø7 mm (1x) - ø3,3 mm (5x)	T-mount, SM2, ø50,8 mm [2"]	ø58 x 250 mm	1030-1064 + 515-532 nm	9273
								515-532 + 343-355 nm	9279
								1030-1064 nm	31303
								515-532 nm	31304
VEX15-HP	1.0x - 5.0x continuous	11 mm	24 mm	High power	ø7 mm (1x) - ø3,3 mm (5x)	T-mount, SM2, ø50,8 mm [2"]	ø58 x 250 mm	343-355 nm	31305

## Mounting options for motorized beam expanders VEX

DESCRIPTION	MOUNTING	WEIGHT	MOUNTING	SKU
VEX13	75 x 28 x 100 mm	500 g	55 mm	29270
VEX18	102 x 28 x 100 mm	500 g	55 mm	29271



# Fixed ratio beam expanders FEX

## Main features

- Divergence adjustment
- Galilean optical design
- UVFS optical elements
- Grease free mechanical design
- Wide wavelength adoption - 200 nm to 2  $\mu$ m

## Application examples

- Laser material processing
- Medical
- Research

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.

## Standard specifications

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

\*Custom design available

## Standard products

ITEM MODEL	EXPANSION	CLEAR INPUT APERTURE	RECOMMENDED MAX. INPUT BEAM SIZE, 1/E <sup>2</sup>	CLEAR OUTPUT APERTURE	MECHANICAL LENGTH	WAVELENGTH	SKU
FEX-2	2 x	11.5 mm	$\varnothing$ 7 mm	23 mm	65 mm	343-355 nm	7723
						515-532 nm	7725
						1030-1064 nm	7727
						1030-1064 + 515-532 nm	11169
FEX-3	3 x	11.5 mm	$\varnothing$ 5.3 mm	23 mm	65 mm	343-355 nm	7733
						515-532 nm	7731
						1030-1064 nm	7729
FEX-4	4 x	11.5 mm	$\varnothing$ 4 mm	23 mm	90 mm	1030-1064 + 515-532 nm	11170
						343-355 nm	7735
						515-532 nm	7737
FEX-5	5 x	11.5 mm	$\varnothing$ 3.2 mm	23 mm	95 mm	1030-1064 nm	7739
						343-355 nm	7741
						515-532 nm	7743
FEX-8	8 x	7 mm	$\varnothing$ 2 mm	23 mm	104 mm	1030-1064 + 515-532 nm	11172
						343-355 nm	7749
						515-532 nm	7752
						1030-1064 nm	7754
						1030-1064 + 515-532 nm	11173

## Mounting options for motorized beam expanders FEX

RECOMMENDED ACCESSORY	FOR BEAM HEIGHT OF	SKU
Adapter SM1 male to M30 X 1 male	-	9338
Adapter SM1 female to C-mount	-	9339
Adapter SM1 female to M30 X 1 male	-	9340
X-Y adjustable (3 adjusters) kinematic mount with post holder	50.8 mm (2")	9341
X-Y adjustable (3 adjusters) kinematic mount with post holder	76.2 - 100 mm (3" - 4")	9342



# Motorized laser power attenuators LPA

## Main features

- Robust design
- Damage threshold up to 10J/cm<sup>2</sup> (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

Optogama 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.

## 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
0,5 - 95 %	2 J/cm <sup>2</sup> (10 ns @ 266 nm)	257 nm	9326
		266 nm	9327
0,2 - 96 %	3 J/cm <sup>2</sup> (10 ns @ 355nm)	343 nm	9264
		355 nm	9263
		515 nm	9262
0,1 - 98 %	5 J/cm <sup>2</sup> (10 ns @ 532 nm)	532 nm	9260
		1030 nm	9259
		1064 nm	9258

## 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

## Main features

- Integrated controller
- Absolute encoder - no homing required
- High accuracy -  $\pm 0,004$  deg (less than  $\pm 0,01$  % 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  $10\text{J}/\text{cm}^2$  (10 ns @ 1064 nm)
- Adjustable polarizer angle

## Application examples

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

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.

## 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
0.5 - 95 %	2 J/cm <sup>2</sup> (10 ns @ 266 nm)	257 nm	11809
		266 nm	11810
	5 J/cm <sup>2</sup> (10 ns @ 532 nm)	515+1030 nm	14898
0.2 - 96 %	3 J/cm <sup>2</sup> (10 ns @ 355nm)	343 nm	11808
		355 nm	11805
	5 J/cm <sup>2</sup> (10 ns @ 532 nm)	515 nm	11807
0.1 - 98 %	5 J/cm <sup>2</sup> (10 ns @ 532 nm)	532 nm	11806
		1030 nm	11804
	10 J/cm <sup>2</sup> (10 ns @ 1064 nm)	1064 nm	11708

## Accessories for laser power attenuators LPA-A

MOUNTING OPTION	FOR BEAM HEIGHT OF	SKU
Post mounting set	76.2 - 100 mm (3" - 4")	9346
Post mounting set	57 - 65 mm (2.2" - 2.6")	9347
Dedicated beam dump with protective window	-	9345



# Manual laser power attenuators LPA-M

## Main features

- Industrial robust design
- Wide wavelength adoption 240 nm - 2  $\mu$ m
- Cost effective

## Application examples

- Laser micromachining
- Laser power attenuation
- Research

Optogama 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.

## 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

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



# OEM laser power attenuator LPA-OEM

## Main features

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

## Application examples

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

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.

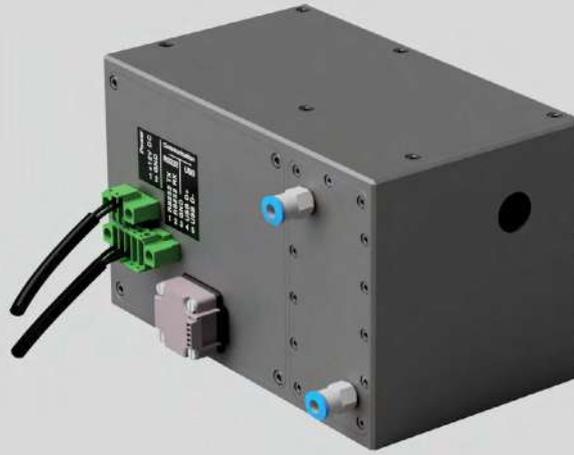
## Standard specifications

LASER POWER ATTENUATOR LPA-OEM SPECIFICATIONS	
Input and output clear aperture	$\varnothing 8$ mm
Power attenuation range	<0,1% to >98%
LIDT coating	>10 J/cm <sup>2</sup> (10 ns @ 1064 nm)
Close to open time	<0,2 sec
Resolution	175,543 $\mu$ steps in full rotation 21,943 $\mu$ steps in min/max rotation (0,002 deg, 7,2 arcsec, 0,035 mrad)
Accuracy	$\pm 10$ $\mu$ steps ( $\pm 0,02$ deg, less than $\pm 0,035$ %)
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
LPA-OEM	0,5 - 95%	2 J/cm <sup>2</sup> (10 ns @ 266 nm)	257 nm	20051
LPA-OEM	0,5 - 95%	2 J/cm <sup>2</sup> (10 ns @ 266 nm)	266 nm	20052
LPA-OEM	0,2 - 96 %	3 J/cm <sup>2</sup> (10 ns @ 355 nm)	343 nm	20053
LPA-OEM	0,2 - 96 %	3 J/cm <sup>2</sup> (10 ns @ 355 nm)	355 nm	20054
LPA-OEM	0,1 - 98 %	5 J/cm <sup>2</sup> (10 ns @ 532 nm)	515 nm	20055
LPA-OEM	0,1 - 98 %	5 J/cm <sup>2</sup> (10 ns @ 532 nm)	532 nm	20056
LPA-OEM	0,5 - 95 %	5 J/cm <sup>2</sup> (10 ns @ 532 nm)	515+1030 nm	20059
LPA-OEM	0,1 - 98 %	10 J/cm <sup>2</sup> (10 ns @ 1064 nm)	1030 nm	20057
LPA-OEM	0,1 - 98 %	10 J/cm <sup>2</sup> (10 ns @ 1064 nm)	1064 nm	20058



# Unpolarized beam motorized laser power attenuators LPA-U

## 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  $\pm 0,005$  deg
- Robust design with water-cooling
- Clear aperture -  $\varnothing 12$  mm
- Fast adjustment - less than 0,5 sec (min to max)
- High damage threshold: up to  $10\text{J}/\text{cm}^2$  (10 ns @ 1064 nm)

## Application examples

- Precise laser micromachining
- Laser power stabilization
- Research

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  $\mu\text{m}$ . 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.

## Standard specifications

### UNPOLARIZED 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
LPA-U	2 - 95%	85 x 93,5 x 135 mm	1070 nm	21710
LPA-U	2,5 - 93%	85 x 93,5 x 135 mm	1064 nm	28839



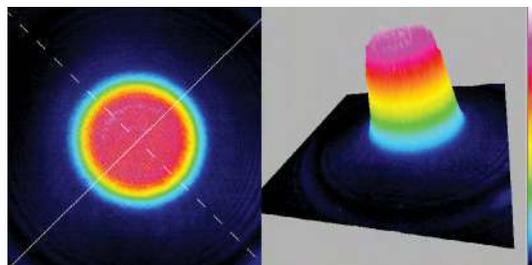
# Flat top converter FTC

## 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<sup>2</sup> (10 ns @ 1064 nm)
- Conversion efficiency up to 70% (while on Flat-Top mode)

## Application examples

- Precise laser micromachining
- Life sciences
- Research



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.

## 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 <sup>2</sup> ] (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	WAVELENGTH	ADJUSTMENT	TYPE	CONTROL INTERFACE	TYPICAL APPLICATION	SKU
FTC	ø 6 mm	1030 nm	Motorised	DOE	USB or RS232	Flat top converter	19750
	ø 6 mm	515 nm	Motorised	DOE	USB or RS232	Flat top converter	19751
	ø 3 mm	1030 nm	Motorised	DOE	USB or RS232	Flat top converter	19752
	ø 3 mm	515 nm	Motorised	DOE	USB or RS232	Flat top converter	19753
	ø 6 mm	1064 nm	Motorised	DOE	USB or RS232	Flat top converter	19754
	ø 3 mm	1064 nm	Motorised	DOE	USB or RS232	Flat top converter	19755
	ø 6 mm	532 nm	Motorised	DOE	USB or RS232	Flat top converter	19756
	ø 3 mm	532 nm	Motorised	DOE	USB or RS232	Flat top converter	19757



# Motorized polarization rotator MRO

## Main features

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

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.

## Standard specifications

SPECIFICATIONS	
Clear aperture	$\phi$ 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/cm <sup>2</sup> ] (10 ns @ 1064 nm)
Close to open time (0 to 45 deg)	$< 0,2$ sec
Resolution	175,543 $\mu$ steps in full rotation 21,943 $\mu$ steps in 45deg rotation (0,002 deg, 7,2 arcsec, 0,035 mrad)
Accuracy	$\pm 10$ $\mu$ steps ( $\pm 0,02$ deg)
Motor	2 phase stepper motor, 200 steps with 256 $\mu$ stepping
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
18 mm	USB or RS232	1064 nm	L/2	10 J/cm <sup>2</sup> (10 ns@1064 nm)	19706
		1030 nm	L/2	10 J/cm <sup>2</sup> (10 ns@1030 nm)	19572
		532 nm	L/2	5 J/cm <sup>2</sup> (10 ns@532 nm)	19705
		515 nm	L/2	5 J/cm <sup>2</sup> (10 ns@515 nm)	19700
		355 nm	L/2	3 J/cm <sup>2</sup> (10 ns@355 nm)	19702
		343 nm	L/2	3 J/cm <sup>2</sup> (10 ns@343 nm)	19701
		266 nm	L/2	2 J/cm <sup>2</sup> (10 ns@266 nm)	19703
		257nm	L/2	2 J/cm <sup>2</sup> (10 ns@257 nm)	19704
		1064 nm	L/4	10 J/cm <sup>2</sup> (10 ns@1064 nm)	19708
		1030 nm	L/4	10 J/cm <sup>2</sup> (10 ns@1030 nm)	19479
		532 nm	L/4	5 J/cm <sup>2</sup> (10 ns@532 nm)	19709
		515 nm	L/4	5 J/cm <sup>2</sup> (10 ns@515 nm)	19478
		355 nm	L/4	3 J/cm <sup>2</sup> (10 ns@355 nm)	13527
		343 nm	L/4	3 J/cm <sup>2</sup> (10 ns@343 nm)	19477
		266 nm	L/4	2 J/cm <sup>2</sup> (10 ns@266 nm)	19711
		257nm	L/4	2 J/cm <sup>2</sup> (10 ns@257 nm)	19710
				without optics	None



# 激光器配件

可选配件装置

Laser  
accessories

# r SSO -



Infrared (IR) viewers



UV-NIR laser beam  
visualizers



Manual 4 axis  
translation stage



4 axis Kinematic  
mount



XY industrial holders



Compact laser  
modules



# Infrared (IR) viewers

## Main features

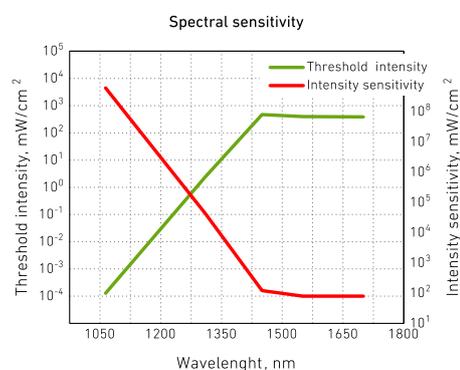
- Spectral region 400 - 1700 nm
- Resolution > 30 Lp/mm
- Hand-held / post mounted
- Up to 10 hours battery life, rechargeable
- Pulsed and CW light detection

## 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

The digital version of the IR viewer is based on the multiphoton absorption (MPA) phenomenon when the laser wavelength exceeds the linear spectral detection range of the silicon material.

In addition, the process of photoelectrons requires spatial and temporal filtering from noise to enhance the visualization of IR photons beyond the 1.1 μm spectrum. By adjusting the gain on a pixel-by-pixel basis, it is possible to achieve imaging up to 1.7 μm.



## Standard specifications

IR-VIEWERS SPECIFICATIONS	
Resolution	>30 Lp/mm
Working distance of lens	12,5 (+/-0,2) mm
Distortion of image	<0,5 %
Battery life (continuous)	Up to 10 hours battery life, rechargeable 2x 18650 batteries
Weight	0,4 kg
Dimensions	153 x 175 x 51 mm

## Standard products

FIELD OF VIEW	MAGNIFICATION	OBJECTIVE LENS	ADJUSTABLE IRIS	FOCUS	SPECTRAL SENSITIVITY	SKU
38°	1X	F1.3/8 mm	Included	0,1 m to infinity	400 - 1700 nm	31150
19°	2X	F1.4/16 mm	Included	0,5 m to infinity	400 - 1700 nm	31152



# UV-NIR laser beam visualizers

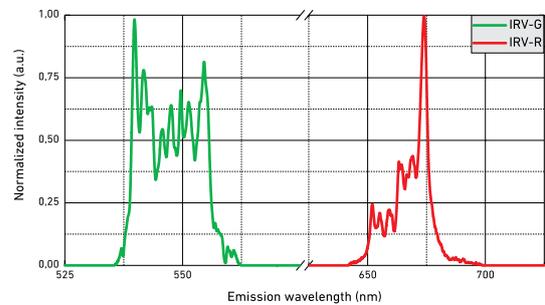
## Main features

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

## Application examples

- Laser alignment
- Research

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.



## Standard products

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



# Manual 4 axis translation stage

## 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

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.

## 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
M-STAGE	75 x 28 x 100 mm	500 g	3mm, 2mm, 1.5 mm HEX	12571
M-STAGE-W	102 x 28 x 100 mm	650 g	3mm, 2mm, 1.5 mm HEX	29135



# 4 axis Kinematic mount

## Main features

- Sapphire contact pads
- Locking mechanism of all 4 axis
- Industrial design
- 4 axis fine adjustment
- Maximum load up to 1 kg

## Application examples

- Variable beam expander VEX fine adjustment
- Industrial mounting of other laser accessories

KMOUNT is an industrial mounting solution for VEX manual variable beam expanders.

This 4-axis manual kinematic mount contains a locking mechanism preserving the aligned position on all 4 axis. It features sapphire contact pads determining long-lasting and smooth micro screw operation.

There are 2x M6 x 0,25 and 2x 3/16"-100 micro screws for adjusting the platform's pitch, yaw, Y, and X-axis.

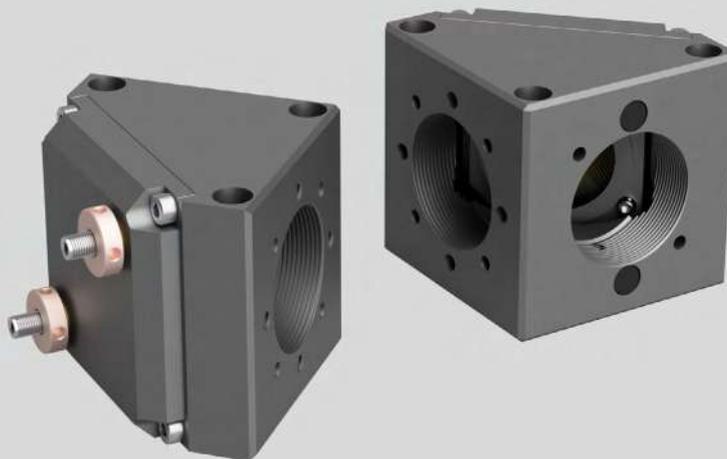
Two micro screws control platform's tilt, while another two-control XY axis. All of them can be adjusted with a 2 mm HEX screwdriver.

## Standard specifications

SPECIFICATIONS	
Travel range	Y axis: 8 mm ( $\pm 4$ mm)
	Z axis: 4 mm ( $\pm 2$ mm)
	Yaw: $\pm 5.5$ deg
	Pitch: $\pm 2.5$ deg
Resolution	Y axis: 8 mm ( $\pm 4$ mm)
	Z axis: 145 $\mu\text{m}/\text{rev}$
	Yaw: 0.018 deg/rev
	Pitch: 0.010 deg/rev
Maximum load	Mounted horizontally 1 kg

## Standard products

DESCRIPTION	MOUNTING	WEIGHT	MOUNTING	SKU
VEX13	75 x 28 x 100 mm	500 g	55 mm	29270
VEX18	102 x 28 x 100 mm	500 g	55 mm	29271



# XY industrial holders

## 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

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 and 3-axis Reflection type - is typically used with mirror.
- 3-axis Reflection + Transmission type - is typically used for splitting or filtering the laser beam.

## Standard specifications

SPECIFICATIONS	
Angular range	±3,2 deg
Z axis*	±1,75 mm
Clear aperture	∅ 16 mm (reflection type) ∅ 12 mm (transmission type)
Max. recommended beam size	∅ 14 mm (reflection type) ∅ 10 mm (transmission type)
Max. recommended beam size 1/e2	∅ 10 mm (reflection type) ∅ 8 mm (transmission type)
Fits	∅ 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

## Standard products

DESCRIPTION	ITEM MODEL	MATERIAL	DIMENSIONS	SKU
XY holders (Reflection)	XYIND-2R-B	Black anodized aluminium	50 x 50 x 50 mm (H x W x L)	20020
XYZ holders (Reflection)	XYIND-3R-B	Black anodized aluminium	50 x 50 x 50 mm (H x W x L)	20021
XYZ holders (Reflection / Transmission)	XYIND-3RT-B	Black anodized aluminium	50 x 50 x 50 mm (H x W x L)	20022
XYZ holders (Reflection)	XYIND-2R-N	Natural anodized aluminium	50 x 50 x 50 mm (H x W x L)	29094
XYZ holders (Reflection)	XYIND-3R-N	Natural anodized aluminium	50 x 50 x 50 mm (H x W x L)	29095
XYZ holders (Reflection / Transmission)	XYIND-3RT-N	Natural anodized aluminium	50 x 50 x 50 mm (H x W x L)	29096
Holder locking nuts (2 pcs)	XYIND-2-LOCKS	Bronze	12,5 x 3,8 mm (D x T)	28250
Holder locking nuts (3 pcs)	XYIND-3-LOCKS	Bronze	12,5 x 3,8 mm (D x T)	28251
Tube seal with o-ring	XYIND-SEAL-SM1-B	Black anodized aluminium	32 x 24 mm (D x L)	28252
Tube seal with o-ring	XYIND-SEAL-SM1-N	Natural anodized aluminium	32 x 24 mm (D x L)	29092
Tube joint with o-ring	XYIND-TUBE-JOINT-B	Black anodized aluminium	32 x 40 mm (D x L)	28253
Tube joint with o-ring	XYIND-TUBE-JOINT-N	Natural anodized aluminium	32 x 40 mm (D x L)	29093
Sealing tube	XYIND-TUBE-N-1	Natural anodized aluminium	22 x 1000 mm (D x L)	28254
Sealing tube (custom length)	XYIND-TUBE-N-C05	Natural anodized aluminium	22 x 0 ... 500 mm (D x L)	28255
Sealing tube (custom length)	XYIND-TUBE-N-C051	Natural anodized aluminium	22 x 500 ... 1000 mm (D x L)	28256
Sealing tube	XYIND-TUBE-B-05	Black anodized aluminium	22 x 500 mm (D x L)	28257
Sealing tube (custom length)	XYIND-TUBE-B-C025	Black anodized aluminium	22 x 0 ... 250 mm (D x L)	28258
Sealing tube (custom length)	XYIND-TUBE-B-C02505	Black anodized aluminium	22 x 250 ... 500mm (D x L)	28259



# Compact laser modules

## Main features

- Industrial design
- 2 axis fine adjustment
- Locking mechanism of all 2 axis

## Application examples

- Beam alignment
- Demonstration of laser systems

The compact laser module (CLM) is a precision-engineered optical tool designed to operate at 520 and 635 nm wavelengths. Offering adjustable beam control, with  $\pm 3^\circ$  pointing angle,  $< 1$  mrad beam divergence, and 4,5 mW of average power. It can be used in laser system alignment, optical experimentation, and educational demonstrations, providing reliability in a compact package.

## Standard specifications

SPECIFICATIONS	
Operation wavelength	520, 635 nm
Mode of operation	CW
Average output power	4,5 $\pm$ 3 mW
Beam mode	Single mode
Beam diameter	4 mm
Beam divergence	$< 1$ mrad
Operating temperature	-10°C to +50°C
Electrical power consumption	3-5 V AC, $< 160$ mA
Laser head size (L x W x H)	39 x 27 x 41 mm
Pointing adjustment	$\pm 3^\circ$
Degree per rotation	0,5°/rotation

## Standard products

WAVELENGTH	AVERAGE POWER	BEAM DIAMETER	LASER HEAD SIZE (L X W X H)	PONTING ADJUSTMENT	SKU
520 nm	4,5 $\pm$ 0,3 mW	4 mm	39 x 27 x 41 mm	$\pm 3^\circ$	31037
635 nm	4,5 $\pm$ 0,3 mW	4 mm	39 x 27 x 41 mm	$\pm 3^\circ$	31038



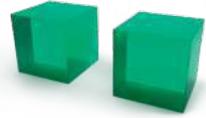
激光器晶体

Laser  
cryst

# r als



Ti:Sapphire



Cr:LiSAF



Pr:YLF



Ho:YLF



Tm, Ho:KYW



Nd-doped



Yb-doped



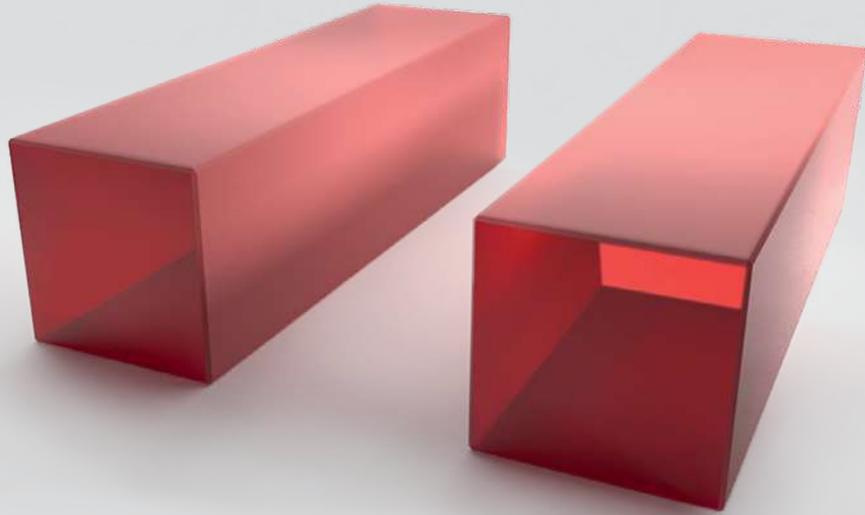
Er-doped



Er, Yb co-doped



Tm-doped



# Ti:Sapphire crystals

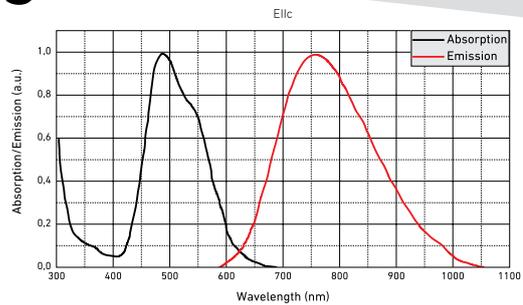
## Main features

- 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

Titanium-doped sapphire ( $\text{Ti}^{3+}:\text{Al}_2\text{O}_3$ ) is a widely used transition-metal-doped laser crystal.  $\text{Ti}^{3+}$  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  $\text{Ti}^{3+}$  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.

## Standard specifications

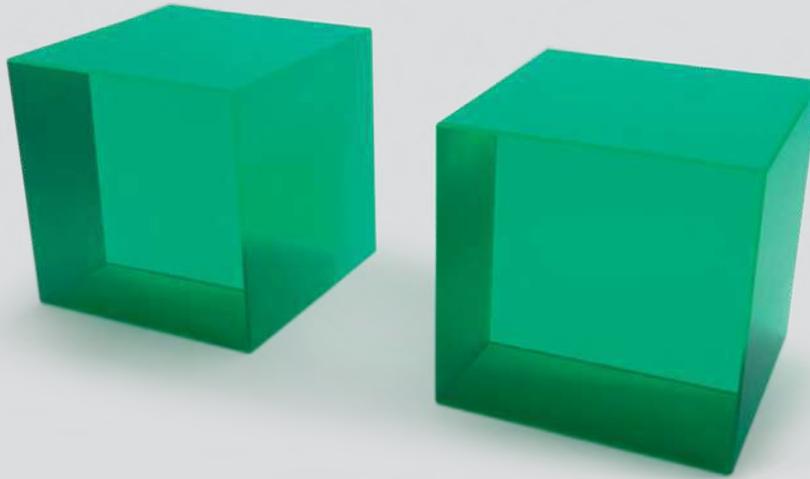
TI:SAPPHIRE CRYSTALS	
Orientation	a-cut
Absorption	90-95% of 532 nm pump radiation
Figure of merit	>150 (for 15 mm and longer crystals)
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<30 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	10-5 5-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	$38 \times 10^{-20} \text{ cm}^2$
Laser wavelength	790 (670-1070) nm
Lifetime of energy level	3,2 μs
Emission cross-section @790 nm	$41 \times 10^{-20} \text{ cm}^2$
Refractive index @800 nm	1,76
Crystal structure	hexagonal
Density	3,98 g/cm³
Mohs hardness	9
Thermal conductivity	$33 \text{ Wm}^{-1} \text{ K}^{-1}$
dn/dT	$13 \times 10^{-6} \text{ K}^{-1}$
Thermal expansion coefficient	$5 \times 10^{-6} \text{ K}^{-1}$
Typical doping level	0,1-0,25 at%

## Standard products

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



# Cr:LiSAF crystals

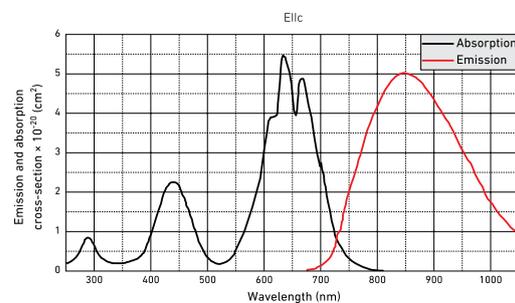
## Main features

- 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

Cr<sup>3+</sup>: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.



## Standard specifications

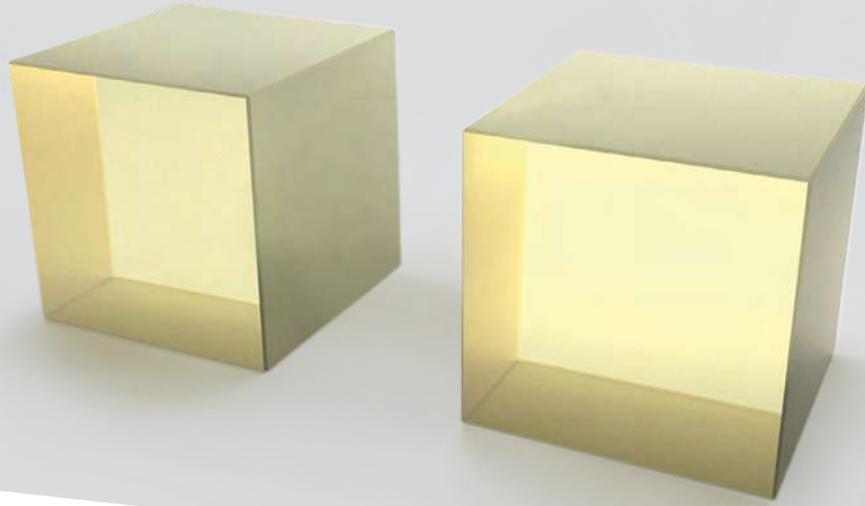
CR:LiSAF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	-λ/10@632,8 nm
Coatings	AR(R<1%)@670 nm + AR(R<0,5%)@700-1100 nm on both faces
Laser induced damage threshold	>10 J/cm <sup>2</sup> @1064 nm, 10 ns
Mount	Unmounted

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	670 nm
Absorption cross-section at peak	5,5 × 10 <sup>-20</sup> cm <sup>2</sup>
Absorption bandwidth at peak wavelength	~100 nm
Laser wavelength	830 (780-920) nm
Lifetime of <sup>4</sup> T <sub>2</sub> energy level	67 μs
Emission cross-section	5 × 10 <sup>-20</sup> cm <sup>2</sup>
Refractive index	1,41
Crystal structure	trigonal
Density	3,45 kg/cm <sup>3</sup>
Mohs hardness	4
Thermal conductivity	4,6(IIa), 5,1 (IIc) Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	-4,2 × 10 <sup>-6</sup> K <sup>-1</sup> (n <sub>x</sub> ), -4,6 × 10 <sup>-6</sup> K <sup>-1</sup> (n <sub>y</sub> )
Thermal expansion coefficient	22 × 10 <sup>-6</sup> (IIa) K <sup>-1</sup> , 3,6 × 10 <sup>-6</sup> (IIc) K <sup>-1</sup>
Typical doping level	0,8-3 at.%

## Standard products

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



# Pr:YLF crystals

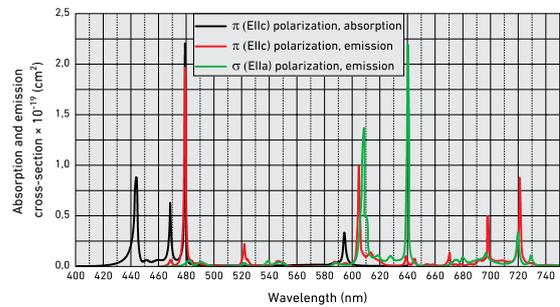
## Main features

- High absorption and emission cross-sections (~ $10^{-19}$  cm<sup>2</sup>)
- Good overlapping of the absorption band in the blue spectral region with the emission lines of the InGaN laser diodes and  $2\omega$ -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

Very few laser materials have necessary properties for realization of lasing in the visible spectral range. Trivalent praseodymium (Pr<sup>3+</sup>) 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, <sup>3</sup>P<sub>0</sub> to <sup>3</sup>F<sub>2</sub>), orange (607 nm, <sup>3</sup>P<sub>0</sub> to <sup>3</sup>H<sub>6</sub>), green (523 nm, <sup>3</sup>P<sub>0</sub> to <sup>3</sup>H<sub>5</sub>), and dark red (720 nm, <sup>3</sup>P<sub>0</sub> <sup>3</sup>F<sub>3</sub>+<sup>3</sup>F<sub>4</sub>) spectral regions. Pr<sup>3+</sup>:YLF has been found to be a promising laser material for producing visible lasers directly and UV lasers through intracavity second-harmonic generation.



## Standard specifications

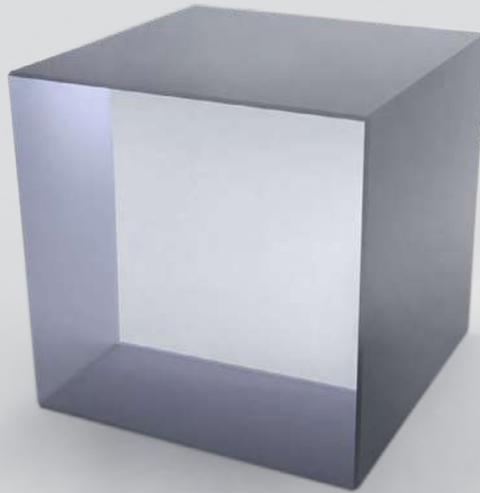
PR:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0.0/-0.1 mm
Length tolerance	±0.1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0.1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	< $\lambda/8$ @632.8 nm
Wavefront distortion	$\lambda/4$ @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/cm <sup>2</sup> @532 nm, 10 ns
Mount	Unmounted

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	444 nm
Absorption cross-section at peak	$8 \times 10^{-20}$ cm <sup>2</sup>
Absorption bandwidth at peak wavelength	~5 nm
Laser wavelength	523 nm, 607 nm, 639 nm, 698 nm, 721 nm
Lifetime of <sup>3</sup> P <sub>0</sub> energy level	50 $\mu$ s
Emission cross-section at 640 nm	$20 \times 10^{-20}$ cm <sup>2</sup>
Refractive index @1064 nm	$n_x = 1.448, n_y = 1.470$
Crystal structure	tetragonal
Density	3.95 g/cm <sup>3</sup>
Mohs hardness	5
Thermal conductivity	6 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	-5.2 $\times 10^{-6}$ (  c) K <sup>-1</sup> , -7.6 $\times 10^{-6}$ (  a) K <sup>-1</sup>
Thermal expansion coefficient	-16 $\times 10^{-6}$ K <sup>-1</sup>
Typical doping level	<1 at%

## Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU
2 x 2 mm	6 mm	Right-angle cut	0.5%	AR/AR@440-444 nm + 500-725 nm	7793
3 x 3 mm	6 mm	Right-angle cut	0.5%	AR/AR@440-444 nm + 500-725 nm	7794
ø5 mm	6 mm	Right-angle cut	0.5%	AR/AR@440-444 nm + 500-725 nm	7795



# Ho:YLF crystals

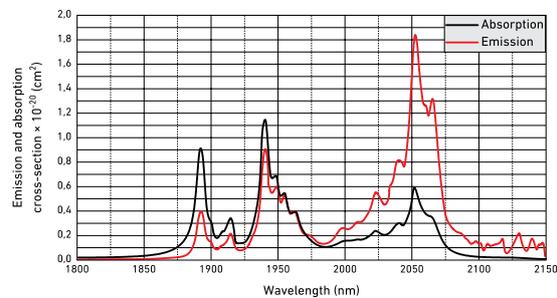
## Main features

- 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
- Defence

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



## 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	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	< $\lambda/10$ @632,8 nm
Coatings	AR(R<0,35%}@1900-2100 nm on both faces
LIDT	>10 J/cm <sup>2</sup> @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 <sup>2</sup>
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 <sup>2</sup>
Refractive index @1064 nm	$n_o = 1,4448, n_e = 1,470$
Crystal structure	tetragonal
Density	3,95 g/cm <sup>3</sup>
Mohs hardness	5
Thermal conductivity	6 Wm <sup>-1</sup> K <sup>-1</sup>
$dn/dT$	$-4,6 \times 10^{-6}$ (  c) K <sup>-1</sup> , $-6,6 \times 10^{-6}$ (  a) K <sup>-1</sup>
Thermal expansion coefficient	$10,1 \times 10^{-6}$ (  c) K <sup>-1</sup> , $14,3 \times 10^{-6}$ (  a) K <sup>-1</sup>
Typical doping level	0,5-1%

## Standard products

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



# Tm, Ho:KYW crystals

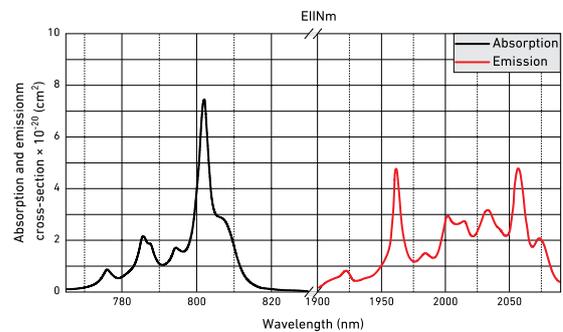
## Main features

- Large and broad polarized absorption and emission bands
- Efficient energy transfer from Tm<sup>3+</sup> to Ho<sup>3+</sup>
- 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)

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



## Standard specifications

TM, HO:KYW CRYSTALS	
Orientation	N <sub>x</sub> -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	20-10 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/cm <sup>2</sup> @2060 nm, 10 ns
Mount	Unmounted

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	802 nm
Absorption cross-section at peak	7,6 × 10 <sup>-20</sup> cm <sup>2</sup>
Absorption bandwidth at peak wavelength	~4 nm
Laser wavelength	2060 nm
Lifetime of <sup>5</sup> I <sub>2</sub> energy level	1,8 ms
Emission cross-section @2056 nm	4,7 × 10 <sup>-20</sup> cm <sup>2</sup>
Refractive index @1040nm	n <sub>x</sub> = 2,05, n <sub>m</sub> = 2,01, n <sub>y</sub> = 1,97
Crystal structure	monoclinic
Density	6,5 g/cm <sup>3</sup>
Mohs hardness	4-5
Thermal conductivity	~3,3 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	dn <sub>m</sub> /dT = -9,2 × 10 <sup>-6</sup> K <sup>-1</sup>
Thermal expansion coefficient	α <sub>x</sub> = 1,83 × 10 <sup>-6</sup> K <sup>-1</sup> , α <sub>m</sub> = 10,29 × 10 <sup>-6</sup> K <sup>-1</sup> , α <sub>y</sub> = 15,94 × 10 <sup>-6</sup> K <sup>-1</sup>
Typical doping level	5 at.% [Tm] 0,5 at.% [Ho]

## Standard products

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



# Nd:KGW crystals

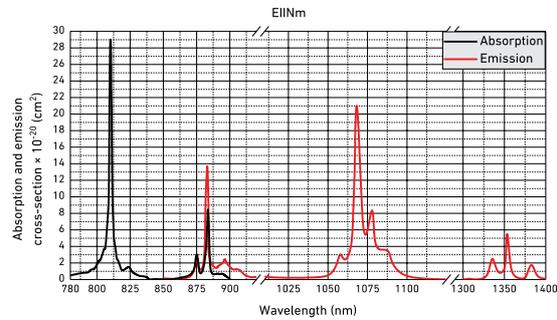
## Main features

- 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

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.



## Standard specifications

ND:KGW CRYSTALS	
Orientation	b(N <sub>z</sub> )-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	20-10 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/cm <sup>2</sup> @1067 nm, 10 ns
Mount	Unmounted

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	811 nm
Absorption cross-section at peak	28 × 10 <sup>20</sup> cm <sup>2</sup>
Absorption bandwidth at peak wavelength	11 nm
Laser wavelength	1067 nm
Lifetime of <sup>4</sup> F <sub>3/2</sub> neodymium energy level	130 μs
Emission cross-section @1067 nm	21 × 10 <sup>20</sup> cm <sup>2</sup>
Refractive index @1067nm	n <sub>o</sub> = 2,033, n <sub>e</sub> = 1,937, n <sub>m</sub> = 1,986
Crystal structure	Monoclinic
Density	7,25 g/cm <sup>3</sup>
Mohs hardness	4-5
Thermal conductivity	~3 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	dn <sub>o</sub> /dT = -15,7×10 <sup>-6</sup> K <sup>-1</sup> dn <sub>e</sub> /dT = -11,8×10 <sup>-6</sup> K <sup>-1</sup> dn <sub>m</sub> /dT = -17,3×10 <sup>-6</sup> K <sup>-1</sup>
Thermal expansion coefficient	α <sub>o</sub> = 1,60 × 10 <sup>-6</sup> K <sup>-1</sup> , α <sub>m</sub> = 4 × 10 <sup>-6</sup> K <sup>-1</sup> , α <sub>e</sub> = 8,5 × 10 <sup>-6</sup> K <sup>-1</sup>
Typical doping level	2-10 at. %

## Standard products

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



# Nd:YAG crystals

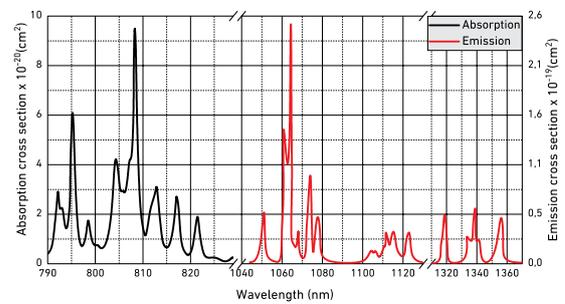
## Main features

- 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

Nd: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.



## 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 <sup>2</sup> @1064 nm, 10 ns
Mount	Unmounted

## Properties

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

## Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS
ø3 mm	10 mm	Right-angle cut	0,8%	AR/AR@1064 nm
	50 mm	Right-angle cut	0,8%	AR/AR@1064 nm
	100 mm	Right-angle cut	0,8%	AR/AR@1064 nm
ø5 mm	10 mm	Right-angle cut	0,8%	AR/AR@1064 nm
	50 mm	Right-angle cut	0,8%	AR/AR@1064 nm
	100 mm	Right-angle cut	0,8%	AR/AR@1064 nm
ø3 mm	10 mm	Right-angle cut	1,1%	AR/AR@1064 nm
	50 mm	Right-angle cut	1,1%	AR/AR@1064 nm
	100 mm	Right-angle cut	1,1%	AR/AR@1064 nm
ø5 mm	10 mm	Right-angle cut	1,1%	AR/AR@1064 nm
	50 mm	Right-angle cut	1,1%	AR/AR@1064 nm
	100 mm	Right-angle cut	1,1%	AR/AR@1064 nm
3 x 3 mm	2 mm	Right-angle cut	1,1%	AR/AR@1064 nm
	2 mm	Right-angle cut	1,1%	HT@808 nm + HR@1064 nm/AR@1064 nm
	3 mm	Right-angle cut	1,1%	AR/AR@1064 nm
	3 mm	Right-angle cut	1,1%	HT@808 nm + HR@1064 nm/AR@1064 nm
	5 mm	Right-angle cut	1,1%	AR/AR@1064 nm
	5 mm	Right-angle cut	1,1%	HT@808 nm + HR@1064 nm/AR@1064 nm
	5 mm	Right-angle cut	1,1%	HT@808 nm + HR@1064 nm/AR@1064 nm



# Nd:YLF crystals

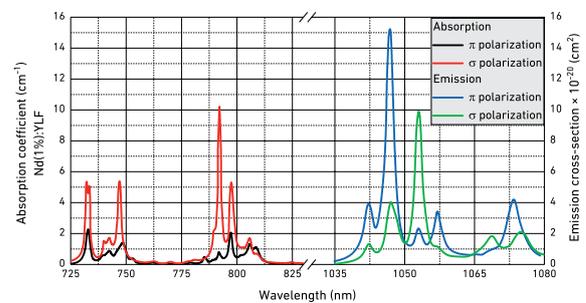
## Main features

- 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

Nd<sup>3+</sup>: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.



## 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	<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<0,5%)@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 <sup>-1</sup>
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 <sup>-20</sup> (E  C) cm <sup>2</sup> @1047 nm 10 × 10 <sup>-20</sup> (E⊥C) cm <sup>2</sup> @1053 nm
Refractive index @1064 nm	n <sub>o</sub> = 1,448, n <sub>e</sub> = 1,470
Crystal structure	tetragonal
Density	3,95 g/cm <sup>3</sup>
Mohs hardness	5
Thermal conductivity	6 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	-4,6 × 10 <sup>-6</sup> (  c) K <sup>-1</sup> , -6,6 × 10 <sup>-6</sup> (  a) K <sup>-1</sup>
Thermal expansion coefficient	8 × 10 <sup>-6</sup> (  c) K <sup>-1</sup> , 13 × 10 <sup>-6</sup> (  a) K <sup>-1</sup>
Typical doping level	1-2 at. %

## Standard products

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



# Nd:YVO<sub>4</sub> crystals

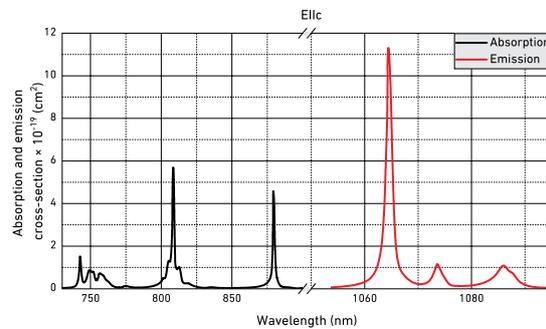
## Main features

- High absorption and gain cross-sections
- Strongly polarization dependent absorption and emission spectra ( $\pi$ -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

Compared to Nd<sup>3+</sup>:YAG crystals, the Nd<sup>3+</sup>:YVO<sub>4</sub> 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<sub>4</sub> crystals are well suited for passively mode-locked lasers with high pulse repetition rates.



A drawback of Nd:YVO<sub>4</sub> 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<sub>4</sub> is better suited as an active medium of high pulse repetition rate Q-switched lasers and CW lasers with a lower lasing threshold.

## Standard specifications

ND:YVO <sub>4</sub> 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	20-10 S-D
Surface flatness	< $\lambda/8$ @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 <sup>2</sup> @1064nm, 10 ns
Mount	Unmounted

## Properties

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

## Standard products

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

# Yb:KGW crystals



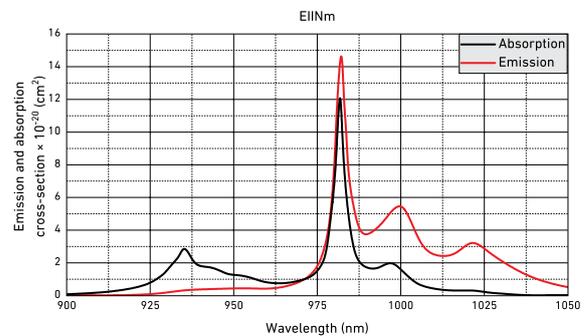
## Main features

- 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

Yb<sup>3+</sup>: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<sup>-1</sup>K<sup>-1</sup>. Yb:KGW crystals exhibit a small quantum defect and it is possible to operate with a quantum defect well below ~4–5%.



## 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	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@970-1070 nm
Laser induced damage threshold	>10 J/cm <sup>2</sup> @1040 nm, 10 ns
Mount	Unmounted

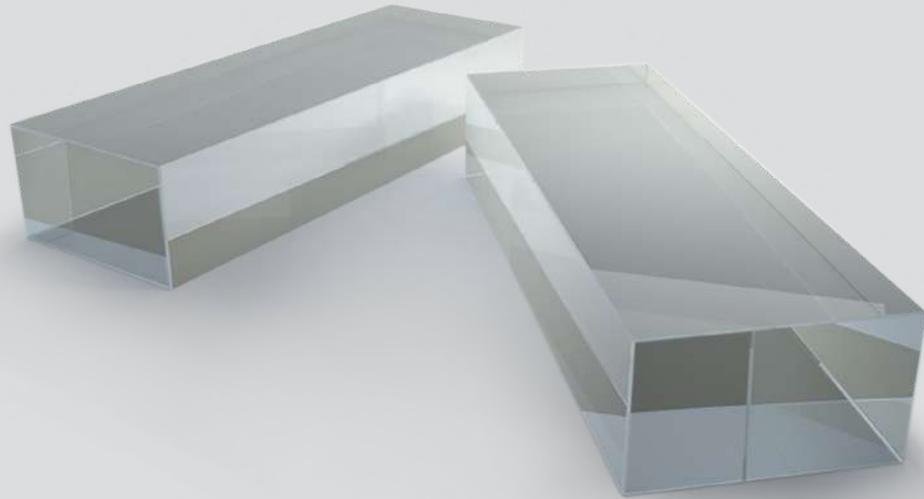
## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	980 nm
Absorption cross-section at peak wavelength	$12 \times 10^{-20} \text{ cm}^2$ (E    N <sub>g</sub> )
Absorption bandwidth at peak wavelength	3,7 nm
Laser wavelength	1025 (1020-1060) nm
Lifetime of <sup>2</sup> F <sub>5/2</sub> ytterbium energy level	240 μs
Emission cross-section at 1030 nm	$3 \times 10^{-20} \text{ cm}^2$ (E    N <sub>g</sub> )
Refractive index at 1064 nm	n <sub>g</sub> = 2,037
	n <sub>s</sub> = 1,986
	n <sub>m</sub> = 2,033
Crystal structure	Monoclinic
Density	7,25 g/cm <sup>3</sup>
Mohs hardness	4-5
Thermal conductivity	K <sub>g</sub> = 2,6 Wm <sup>-1</sup> K <sup>-1</sup>
	K <sub>s</sub> = 3,8 Wm <sup>-1</sup> K <sup>-1</sup>
	K <sub>m</sub> = 3,4 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	dn <sub>g</sub> /dT = -15,7 × 10 <sup>-6</sup> K <sup>-1</sup>
	dn <sub>s</sub> /dT = -11,8 × 10 <sup>-6</sup> K <sup>-1</sup>
	dn <sub>m</sub> /dT = -17,3 × 10 <sup>-6</sup> K <sup>-1</sup>
Thermal expansion coefficient	α <sub>g</sub> = 1,7 × 10 <sup>-6</sup> K <sup>-1</sup>
	α <sub>s</sub> = 11,01 × 10 <sup>-6</sup> K <sup>-1</sup>
	α <sub>m</sub> = 17,37 × 10 <sup>-6</sup> K <sup>-1</sup>
Typical doping level	1-5 at. %

## Standard products

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

# Yb:KYW crystals



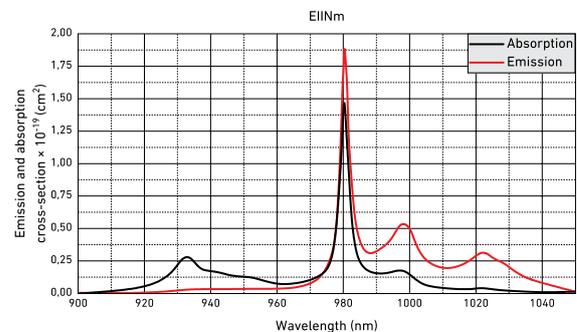
## Main features

- 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

Yb<sup>3+</sup>: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<sup>-1</sup>K<sup>-1</sup>. Yb:KYW crystals also feature a small quantum defect.



## 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	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@970-1070 nm
Laser induced damage threshold	>10 J/cm <sup>2</sup> @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 <sup>-20</sup> cm <sup>2</sup> (E    N <sub>m</sub> )
Absorption bandwidth at peak wavelength	~3 nm
Laser wavelength	1020 (1020-1050) nm
Lifetime of <sup>2</sup> F <sub>5/2</sub> ytterbium energy level	230 μs
Emission cross-section at 1030 nm	2,5 × 10 <sup>-20</sup> cm <sup>2</sup> (E    N <sub>m</sub> )
Refractive index at 1064 nm	n <sub>o</sub> = 2,037 n <sub>e</sub> = 1,986 n <sub>m</sub> = 2,033
Crystal structure	Monoclinic
Density	6,61 g/cm <sup>3</sup>
Mohs hardness	4-5
Thermal conductivity	~3,3 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	dn <sub>o</sub> /dT = -13,08 × 10 <sup>-6</sup> K <sup>-1</sup> dn <sub>e</sub> /dT = -7,61 × 10 <sup>-6</sup> K <sup>-1</sup> dn <sub>m</sub> /dT = -11,83 × 10 <sup>-6</sup> K <sup>-1</sup>
Thermal expansion coefficient	α <sub>o</sub> = 1,9 × 10 <sup>-6</sup> K <sup>-1</sup> α <sub>e</sub> = 10,3 × 10 <sup>-6</sup> K <sup>-1</sup> α <sub>m</sub> = 16,5 × 10 <sup>-6</sup> K <sup>-1</sup>
Typical doping level	1-100 at. %

## Standard products

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

# Yb:YAG crystals

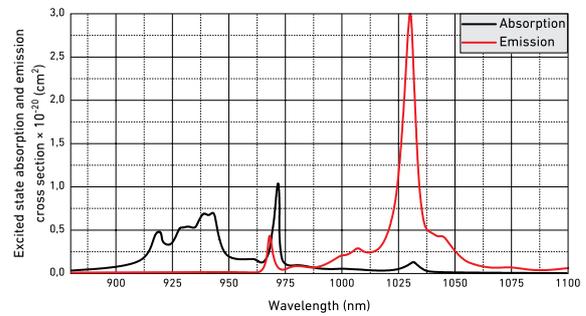
## Main features

- 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

Yb<sup>3+</sup>:YAG crystals feature a 950  $\mu$ s 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.



## Standard specifications

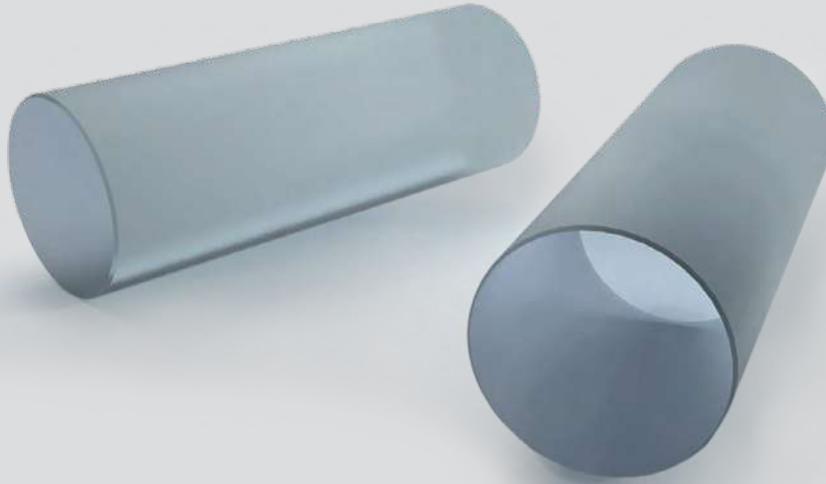
YB:YAG CRYSTALS	
Orientation	[111]
Extinction ratio	>28 dB
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	$\pm$ 0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	10-5 S-D
Surface flatness	< $\lambda$ /10@632,8 nm
Wavefront distortion	$\lambda$ /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/cm <sup>2</sup> @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 <sup>2</sup>
Absorption bandwidth at peak wavelength	18 nm
Laser wavelength	1030 nm
Lifetime of ${}^2F_{5/2}$ ytterbium energy level	950 $\mu$ s
Emission cross-section @1030 nm	$2,1 \times 10^{-20}$ cm <sup>2</sup>
Refractive index @632,8 nm	1,83
Crystal structure	Cubic
Density	4,56 g/cm <sup>3</sup>
Mohs hardness	8,5
Thermal conductivity	$\sim$ 13 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	$7,8 \times 10^{-6}$ K <sup>-1</sup>
Thermal expansion coefficient	$6,2 \times 10^{-6}$ K <sup>-1</sup>
Typical doping level	1-20 at. %

## Standard products

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



# Yb:CaF<sub>2</sub> crystals

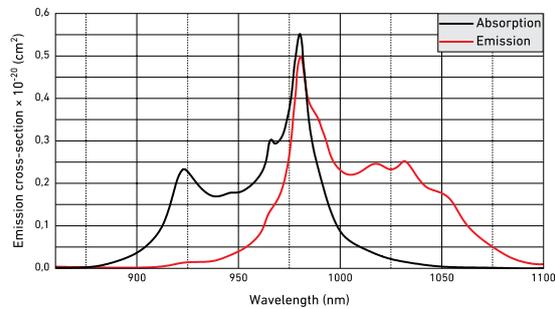
## Main features

- Isotropic crystal (cubic symmetry)
- Low quantum defect
- Long lifetime of the <sup>2</sup>F<sub>5/2</sub> 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

Yb<sup>3+</sup>:CaF<sub>2</sub> 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.



## Standard specifications

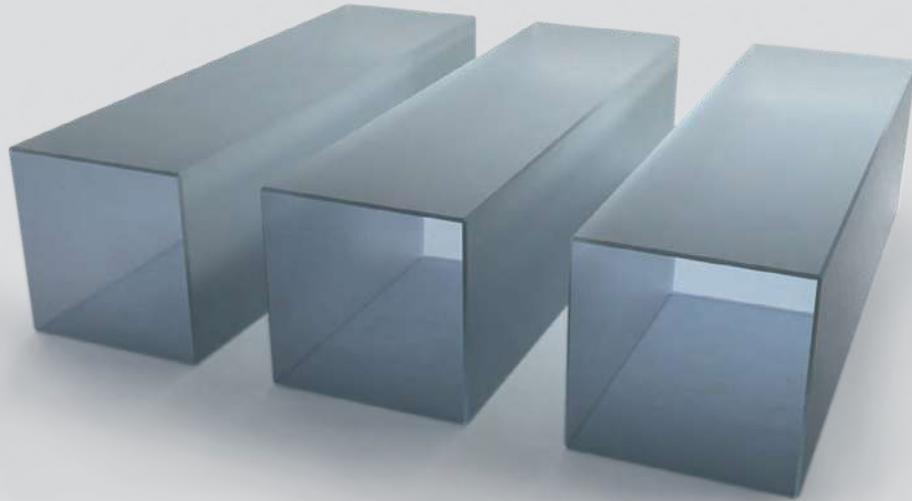
YB:CAF <sub>2</sub> CRYSTALS	
Orientation	[111]
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	20-10 5-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@980 nm + AR(R< 0,2%)@1040-1070 nm
Laser induced damage threshold	>10 J/cm <sup>2</sup> @1040 nm, 10 ns
Mount	Unmounted

## Properties

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

## Standard products

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



# Yb:YAB crystals

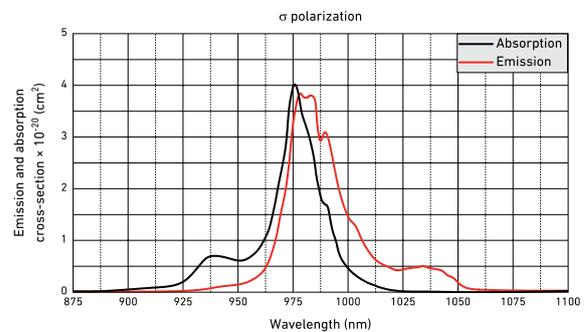
## Main features

- 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

Yb<sup>3+</sup>: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<sup>3+</sup> 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.



## 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	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0.1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/10@632.8 nm
Coatings	Antireflective (AR) coatings on both faces
Laser induced damage threshold	>10 J/cm <sup>2</sup> @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 × 10 <sup>20</sup> cm <sup>-2</sup>
Absorption bandwidth at peak wavelength	20 nm
Laser wavelength	1040 nm
Lifetime of <sup>2</sup> F <sub>5/2</sub> energy level	680 μs
Emission cross-section @1040 nm	0.5 × 10 <sup>20</sup> cm <sup>-2</sup>
Refractive index @632.8 nm	n <sub>o</sub> = 1.7757, n <sub>e</sub> = 1.7015
Crystal structure	Trigonal
Density	3.84 g/cm <sup>3</sup>
Mohs hardness	7.5
Thermal conductivity	~6 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	1.4 × 10 <sup>-6</sup> (IIa) K <sup>-1</sup> , 4.8 × 10 <sup>-6</sup> (IIc) K <sup>-1</sup>
Thermal expansion coefficient	2 × 10 <sup>-6</sup> (IIa) K <sup>-1</sup> , 9.5 × 10 <sup>-6</sup> (IIc) K <sup>-1</sup>
Typical doping level	10 at%

## Standard products

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



# Yb:YAP crystals

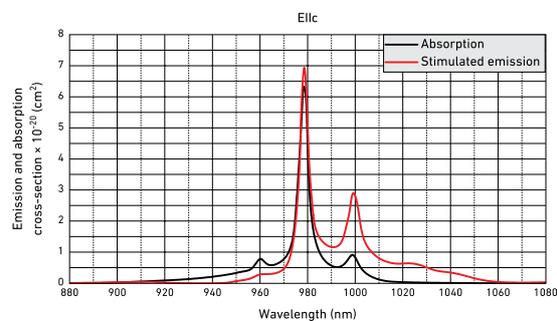
## Main features

- 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

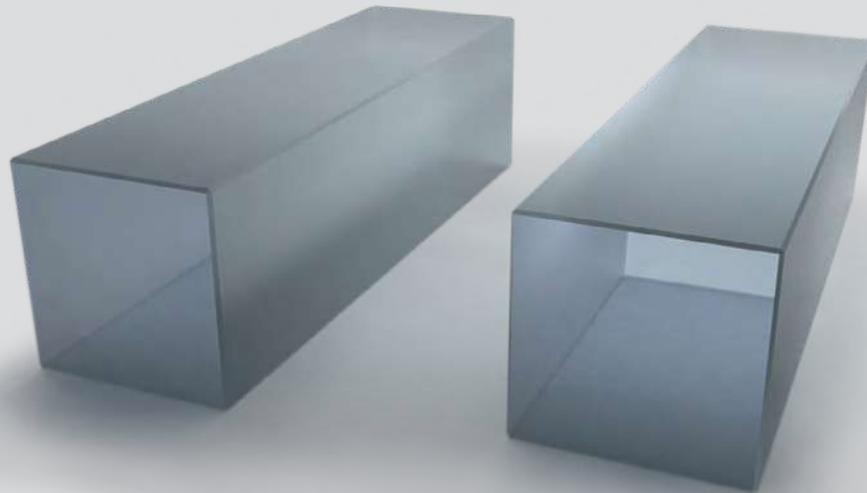
Yttrium aluminate doped with Yb<sup>3+</sup>, (Yb<sup>3+</sup>YAP) is a biaxial orthorhombic crystal. YAP crystal hardness and thermal conductivity are similar to YAG but exhibits a highly anisotropic thermal expansion coefficient and is birefringent. Emission wavelengths are polarized, while emission 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.



## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	978 nm
Absorption cross-section at peak	$6,6 \times 10^{-20} \text{ cm}^2$
Absorption bandwidth at peak wavelength	4 nm
Laser wavelength	1040 nm
Lifetime of $^3F_{4,2}$ energy level	500 $\mu\text{s}$
Emission cross-section @1040 nm	$0,5 \times 10^{-20} \text{ cm}^2$
Refractive index @632.8 nm	1,96 (IIa), 1,94 (IIb), 1,97 (IIc)
Crystal structure	orthorhombic
Density	5,35 g/cm <sup>3</sup>
Mohs hardness	8,5
Thermal conductivity	11,7 (IIa), 10,0 (IIb), 13,3 (IIc) Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	$7,7 \times 10^{-6}$ (IIa) K <sup>-1</sup> , $11,7 \times 10^{-6}$ (IIb) K <sup>-1</sup> , $8,3 \times 10^{-6}$ (IIc) K <sup>-1</sup>
Thermal expansion coefficient	$2,32 \times 10^{-6}$ (IIa) K <sup>-1</sup> , $8,08 \times 10^{-6}$ (IIb) K <sup>-1</sup> , $8,7 \times 10^{-6}$ (IIc) K <sup>-1</sup>
Typical doping level	<2 at. %

# Yb:YLF crystals

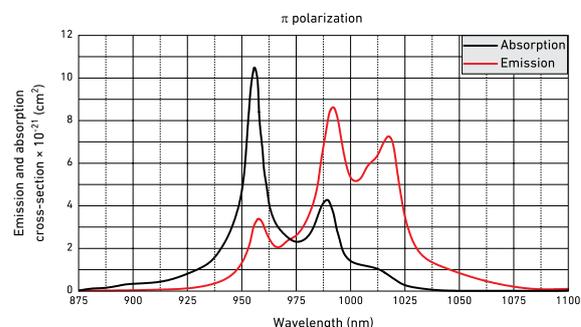


## Main features

- Simple electronic structure excludes excited-state absorption and also a variety of detrimental quenching processes
- Broad and smooth emission spectrum
- Wide tuning range
- Absorption spectra are well matched with the emission wavelength of InGaAs laser diodes
- Low quantum defect
- Custom crystals available upon request

## Application examples

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



## Standard specifications

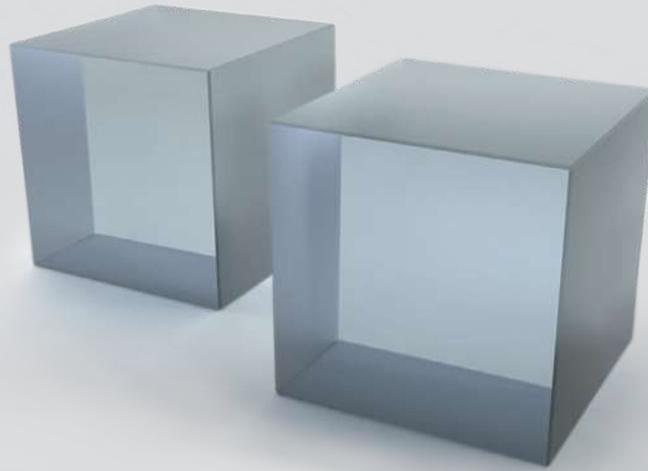
YB:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@960 nm + 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	$10,5 \times 10^{-21} \text{ cm}^2$
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	$4,1 \times 10^{-21} \text{ cm}^2$
Refractive index @1040nm	~1,4
Crystal structure	tetragonal
Density	3,95 g/cm³
Mohs hardness	5
Thermal conductivity	6 Wm⁻¹K⁻¹
dn/dT	$-4,6 \times 10^{-6} \text{ (IIC) K}^{-1}, -6,6 \times 10^{-6} \text{ (IIa) K}^{-1}$
Thermal expansion coefficient	$8 \times 10^{-6} \text{ (IIC) K}^{-1}, 13 \times 10^{-6} \text{ (IIa) K}^{-1}$
Typical doping level	5-20 at.%

## Standard products

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



# Yb:YVO<sub>4</sub> crystals

## Main features

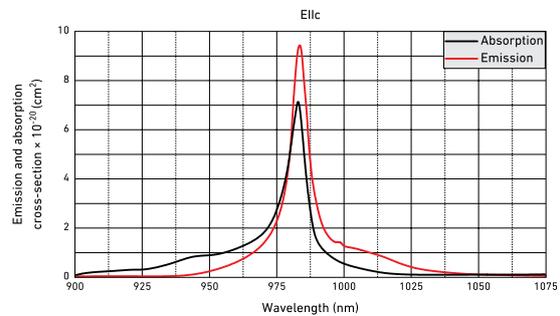
- The simple electronic structure excludes excited-state absorption and also a variety of detrimental quenching processes
- Broad and smooth emission spectrum
- Low quantum defect
- Custom crystals available upon request

## Application examples

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

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

Yb<sup>3+</sup>:YVO<sub>4</sub> 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<sub>4</sub> crystals can be used as an active medium in high-power thin-disk lasers.



## Properties

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



# Er:KYW crystals

## Main features

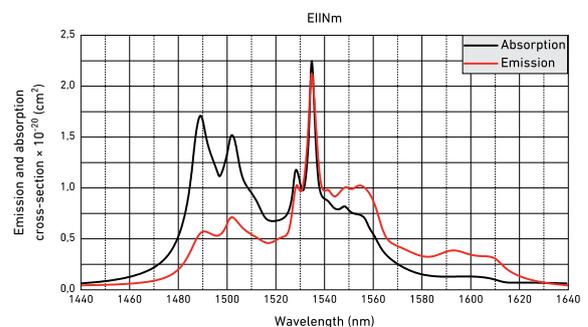
- Strong absorption bandwidth near 1534 nm corresponding to InGaAsP/ InP laser diode emission
- Wide emission bandwidth near 1600 nm
- Custom crystals available upon request

## Application examples

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

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

Er<sup>3+</sup>: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.



## Properties

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



# Er:YAG crystals

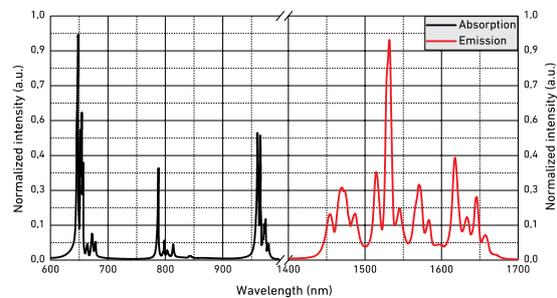
## Main features

- 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

Er<sup>3+</sup>: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.



## Standard specifications

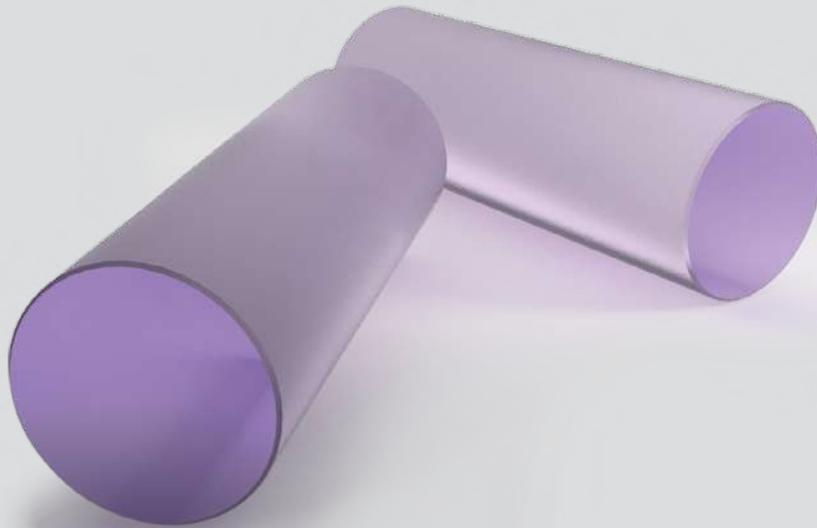
ER:YAG CRYSTALS	
Orientation	[111]
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	Uncoated, coatings 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 <sup>-20</sup> cm <sup>2</sup> @1470 nm
Absorption bandwidth at peak wavelength	~2-3 nm @ 1470 nm
Laser wavelength	1617, 1645, 2940 nm
Lifetime of <sup>4</sup> I <sub>3/2</sub> and <sup>4</sup> I <sub>1/2</sub> erbium energy level	6,0 ms ( <sup>4</sup> I <sub>3/2</sub> ), 0,1 ms ( <sup>4</sup> I <sub>1/2</sub> )
Emission cross-section at wavelength	2,6 × 10 <sup>-20</sup> @2940 nm 5,2 × 10 <sup>-21</sup> @1645 nm
Refractive index @1064 nm	1,82
Crystal structure	Cubic
Density	4,56 g/cm <sup>3</sup>
Mohs hardness	8,5
Thermal conductivity	~13 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT @1064 nm	7,8 × 10 <sup>-6</sup> K <sup>-1</sup>
Thermal expansion coefficient	~7 × 10 <sup>-6</sup> K <sup>-1</sup>
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
5 x 5 mm	3 mm	Brewster-angle cut	0,15%	Uncoated	7852
	2 mm	Brewster-angle cut	50%	Uncoated	7853



# Er:YLF crystals

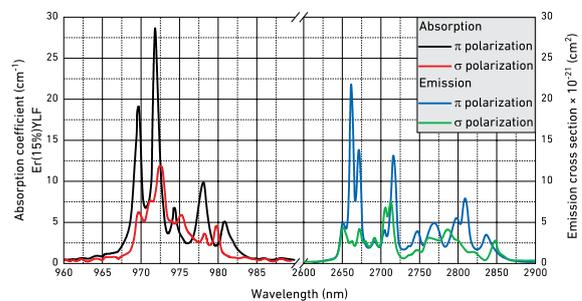
## Main features

- A low phonon frequency
- Long lifetimes of the laser emitting levels
- Wide transparency range (from the VUV to the 10  $\mu\text{m}$  region)
- Negative thermo-optic coefficient
- Custom crystals available upon request

## Application examples

- CW and Q-switched  $\sim 3 \mu\text{m}$  lasers for oral surgery, dentistry, implant dentistry, and otolaryngology
- Up-conversion visible lasers for display technology, medicine (diagnosis and treatment)

Er<sup>3+</sup>: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  $\mu\text{m}$  region. Negative Er<sup>3+</sup>: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.



## 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	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 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 <sup>-1</sup>
Absorption bandwidth at peak wavelength	~1 nm
Laser wavelength	2810 nm
Lifetime of <sup>4</sup> I <sub>11/2</sub> erbium energy level	4 ms
Emission cross-section @2800 nm	1,5 × 10 <sup>-20</sup> cm <sup>2</sup>
Refractive index @2070 nm	n <sub>o</sub> = 1,442, n <sub>e</sub> = 1,464
Crystal structure	tetragonal
Density	3,95 g/cm <sup>3</sup>
Mohs hardness	5
Thermal conductivity	~5 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	-2 × 10 <sup>-6</sup> (IIa) K <sup>-1</sup> , -4,1 × 10 <sup>-6</sup> (IIc) K <sup>-1</sup>
Thermal expansion coefficient	8 × 10 <sup>-6</sup> K <sup>-1</sup>
Typical doping level	15 at. %

## Standard products

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



# Er, Yb:phosphate glass

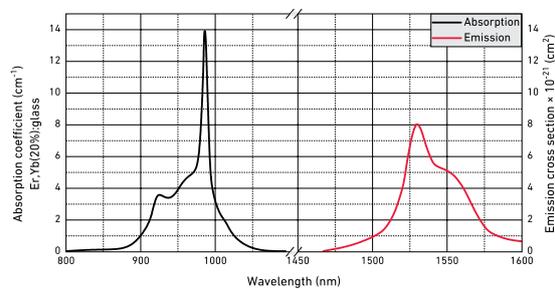
## Main features

- 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

Er<sup>3+</sup>, Yb<sup>3+</sup> 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  $\mu\text{m}$ . Phosphate glass combines a long lifetime (~8 ms) of  $^4I_{13/2}$  Er<sup>3+</sup> upper laser level with a low (2-3 ms) lifetime of  $^4I_{11/2}$  Er<sup>3+</sup> level that is in resonance with Yb<sup>3+</sup>  $^2F_{5/2}$  excited state. Fast non-radiative multiphonon 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<sup>3+</sup> and Er<sup>3+</sup> ions, excited at the  $^2F_{5/2}$  and the  $^4I_{11/2}$  levels, respectively.



## Standard specifications

ER, YB:PHOSPHATE GLASS ELEMENTS	
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	20-10 S-D
Surface flatness	< $\lambda/10$ @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/cm <sup>2</sup> @1535 nm, 10 ns
Mount	Unmounted

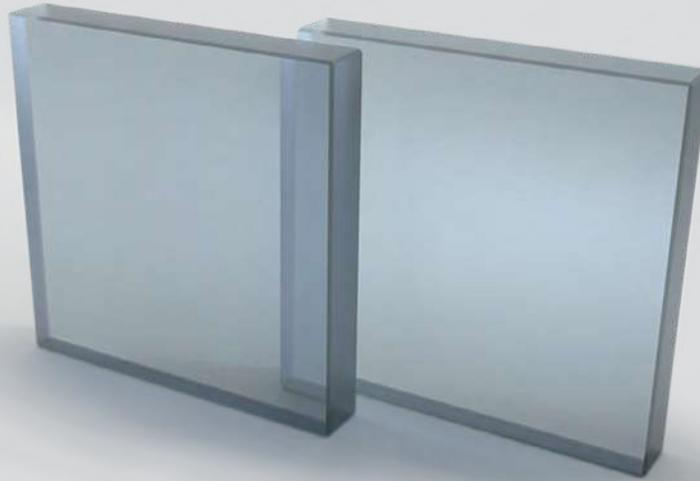
## Properties

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

## Standard products

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

# Er, Yb:YAB crystals



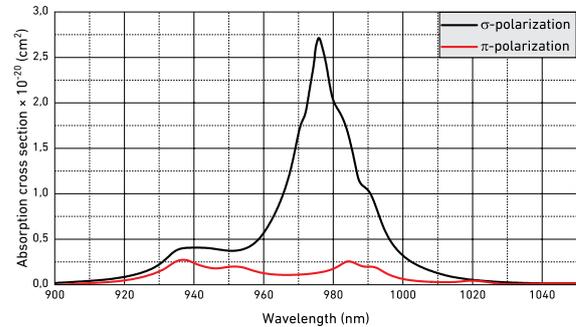
## Main features

- Uniaxial crystal with trigonal structure
- High thermal conductivity
- Wide absorption bandwidth near 976 nm
- High absorption and emission cross-sections
- Extremely high Yb<sup>3+</sup> to Er<sup>3+</sup> 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

Er<sup>3+</sup>, Yb<sup>3+</sup> 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<sup>-1</sup>K<sup>-1</sup> and 6 Wm<sup>-1</sup>K<sup>-1</sup> along a-axis and c-axis, respectively.



It also features a highly effective Yb<sup>3+</sup> to Er<sup>3+</sup> energy transfer (~94%) and weak up conversion losses due to the very short lifetime of <sup>4</sup>I<sub>11/2</sub> excited state (~80 ns) facilitated by a high maximum phonon energy of the host material (hν<sub>max</sub> ~1500 cm<sup>-1</sup>). A strong and wide (~17 nm) absorption band is observed at 976 nm that coincides with the emission spectrum of InGaAs laser diodes.

## Standard specifications

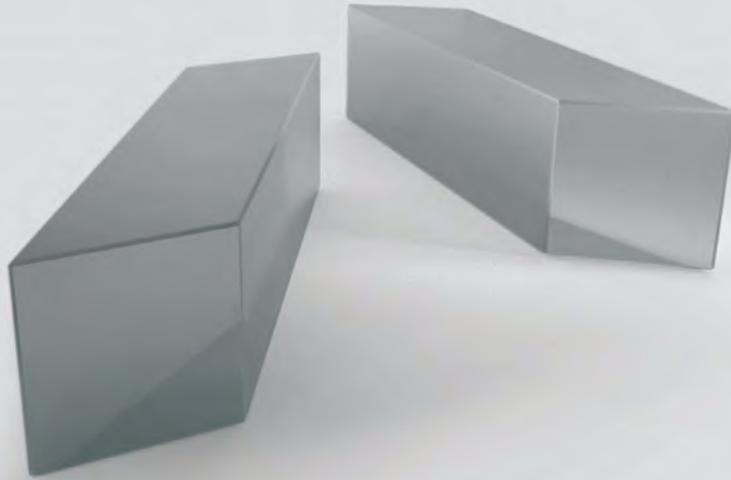
ER, YB:YAB CRYSTALS	
Orientation	c-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,15 mm at 45°
Surface quality	20-10 S-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR@R<1%@940 nm + AR(R<0,25%}@1480-1600 nm
Laser induced damage threshold	>10 J/cm <sup>2</sup> @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 × 10 <sup>-20</sup> cm <sup>2</sup>
Absorption bandwidth at peak wavelength	17 nm
Laser wavelength	1522, 1531, 1543, 1550, 1602 nm
Lifetime of <sup>4</sup> I <sub>13/2</sub> erbium energy level	0,32 ms
Emission cross-section @1531 nm	2,5 × 10 <sup>-20</sup> cm <sup>2</sup>
Yb to Er energy transfer efficiency	>90 %
Refractive index @632.8 nm	n <sub>o</sub> = 1,7757, n <sub>e</sub> = 1,7015
Crystal structure	trigonal
Density	3,84 g/cm <sup>3</sup>
Mohs hardness	7,5
Thermal conductivity	7,7 (IIa), 6 (IIc) Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	1,4 × 10 <sup>-4</sup> (IIa), 4,8 × 10 <sup>-4</sup> (IIc) K <sup>-1</sup>
Thermal expansion coefficient	2 × 10 <sup>-4</sup> (IIa), 9,5 × 10 <sup>-4</sup> (IIc) K <sup>-1</sup>
Typical doping level	1-2 at.% [Er] 8-15 at.% [Yb]

## Standard products

FACE DIMENSIONS	LENGTH	END FACES	DOPING	COATINGS	SKU
3 x 3 mm	1 mm	Brewster-angle cut	12% Yb, 1.5% Er	Uncoated	7068
		Right-angle cut	12% Yb, 1.5% Er	AR/AR@976 nm + 1480-1600 nm	7065
	2 mm	Brewster-angle cut	12% Yb, 1.5% Er	Uncoated	7069
		Right-angle cut	12% Yb, 1.5% Er	AR/AR@976 nm + 1480-1600 nm	7066
	3 mm	Brewster-angle cut	12% Yb, 1.5% Er	Uncoated	7070
		Right-angle cut	12% Yb, 1.5% Er	AR/AR@976 nm + 1480-1600 nm	7067



# Tm:YLF crystals

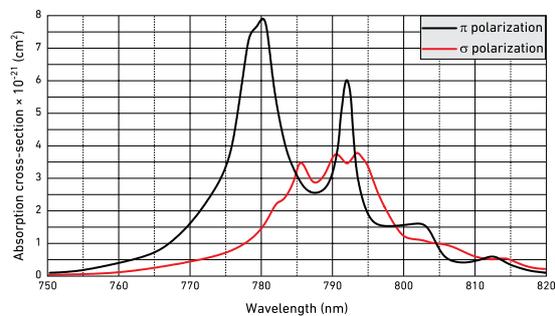
## Main features

- 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<sup>3+</sup>:YAG lasers

Tm<sup>3+</sup>: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<sup>3+</sup>:YLF lasers are ideal pump sources for Ho<sup>3+</sup>:YAG lasers. This is due to a good overlap of Tm<sup>3+</sup>:YLF emission and Ho<sup>3+</sup>:YAG absorption spectra and capacity of producing linearly polarized output. What is more, the refractive index of Tm<sup>3+</sup>:YLF decreases with temperature, leading to a negative thermal lens that is partly compensated by a positive lens effect due to end face bulging.



## Standard specifications

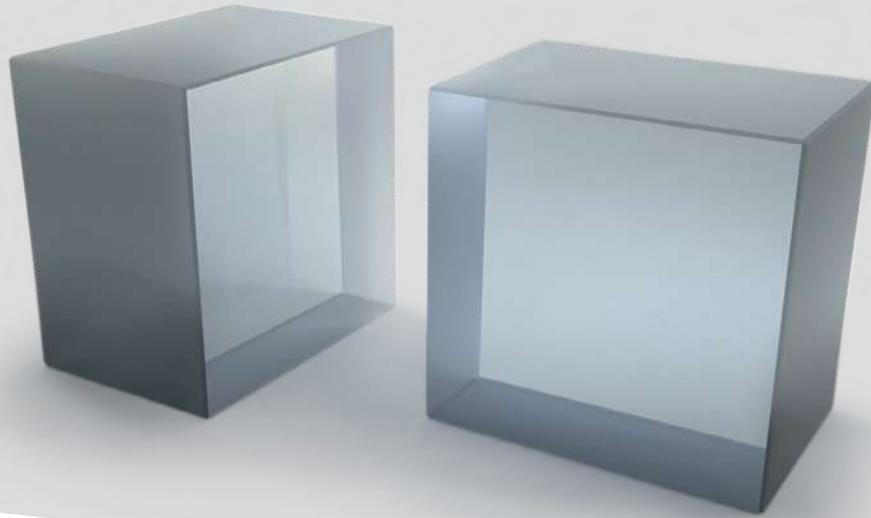
TM:YLF CRYSTALS	
Orientation	a-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 5-D
Surface flatness	<λ/10@632,8 nm
Coatings	AR(R<0,5%)@792 nm + AR(R< 0,35%)@1800-1960 nm on both faces
Laser induced damage threshold	>10 J/cm <sup>2</sup> @1900 nm, 10 ns
Mount	Unmounted

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES	
Absorption peak wavelength	792 nm
Absorption cross-section at peak	0,55 × 10 <sup>-20</sup> cm <sup>2</sup>
Absorption bandwidth at peak wavelength	16 nm
Laser wavelength	1900 nm
Lifetime of <sup>3</sup> F <sub>4</sub> thulium energy level	16 ms
Emission cross-section @1900 nm	0,4 × 10 <sup>-20</sup> cm <sup>2</sup>
Refractive index @1064 nm	n <sub>o</sub> = 1,448, n <sub>e</sub> = 1,470
Crystal structure	tetragonal
Density	3,95 g/cm <sup>3</sup>
Mohs's hardness	5
Thermal conductivity	6 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	-4,6 × 10 <sup>-6</sup> (IIC) K <sup>-1</sup> , -6,6 × 10 <sup>-6</sup> (IIa) K <sup>-1</sup>
Thermal expansion coefficient	10,1 × 10 <sup>-6</sup> (IIC) K <sup>-1</sup> , 14,3 × 10 <sup>-6</sup> (IIa) K <sup>-1</sup>
Typical doping level	2-4 at.%

## Standard products

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



# Tm:KYW crystals

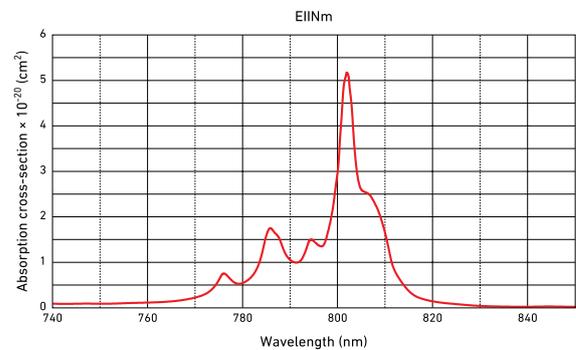
## Main features

- 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  $\mu\text{m}$  for application in surgery, range finding and environmental monitoring
- 2  $\mu\text{m}$  wavelength region femtosecond lasers

Double tungstate crystals are optically biaxial and their optical properties have to be described within the frame of optical indicatrix axes ( $N_p$ ,  $N_m$  and  $N_g$ ). 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.



## Standard specifications

TM:KYW CRYSTALS	
Orientation	$N_z$ -cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	$\pm 0,1$ mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	20-10 S-D
Surface flatness	$\lambda/10$ @632,8 nm
Coatings	AR(R<0,5%)@802 nm + AR(R< 0,35%)@1900-2000 nm on both faces
Laser induced damage threshold	>10 J/cm <sup>2</sup> @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 <sup>2</sup>
Absorption bandwidth at peak wavelength	5,5 nm
Laser wavelength	1910 nm
Lifetime of <sup>2</sup> F <sub>3</sub> energy level	1,1 ms
Emission cross-section @1910 nm	$1,15 \times 10^{-20}$ cm <sup>2</sup>
Refractive index @1040nm	$n_x = 2,05, n_m = 2,01, n_z = 1,97$
Crystal structure	Monoclinic
Density	6,5 g/cm <sup>3</sup>
Mohs hardness	4-5
Thermal conductivity	$\sim 3,3$ Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	$dn_m/dT = -9,2 \times 10^{-6}$ K <sup>-1</sup>
Thermal expansion coefficient	$\alpha_x = 1,83 \times 10^{-6}$ K <sup>-1</sup> , $\alpha_m = 10,29 \times 10^{-6}$ K <sup>-1</sup> , $\alpha_z = 15,94 \times 10^{-6}$ K <sup>-1</sup>
Typical doping level	~5 at. %

## Standard products

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

# Passive Q-switch crystal

激光器晶体

被动调Q晶体



# ive it ch als



Cr:YAG crystals



V:YAG crystals



Co:Spinel crystals

# Cr:YAG crystals



## 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

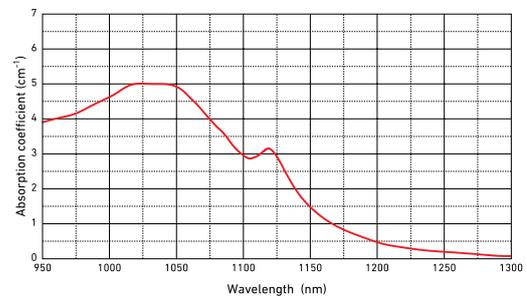
## Standard specifications

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	<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<0,15%)@1064 nm on both sides
Laser induced damage threshold	>10 J/cm²@1064 nm, 10 ns
Mount	Unmounted

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES						
Material	$\sigma_{gsa}^{(1)}$ @1,064 $\mu\text{m}$	$\sigma_{gsa}^{(2)}$ @1,064 $\mu\text{m}$	$\tau_{sa}^{(3)}$	Laser crystal	$\lambda_{laser}$	$\sigma_{gsa}^{(1)}/\sigma_{em}^{(4)}$
Cr <sup>4+</sup> :Y <sub>2</sub> Al <sub>2</sub> O <sub>7</sub>	$46 \times 10^{19} \text{ cm}^2$	$8,2 \times 10^{19} \text{ cm}^2$	3,4 $\mu\text{s}$	Nd:YAG	0,946 $\mu\text{m}$	130
				Nd:YAG	1,06 $\mu\text{m}$	17
				Nd:GSAG	1,06 $\mu\text{m}$	55
				Nd:YVO <sub>4</sub>	1,06 $\mu\text{m}$	3,5
				Nd:GdVO <sub>4</sub>	1,06 $\mu\text{m}$	5
				Nd:LuVO <sub>4</sub>	1,06 $\mu\text{m}$	3,4
				Nd:LSB	1,06 $\mu\text{m}$	40
				Nd:YAP	1,08 $\mu\text{m}$	14
				Yb:NLM	1,01 $\mu\text{m}$	500
				Yb:YVO <sub>4</sub>	1,02 $\mu\text{m}$	625
				Yb:GGG	1,025 $\mu\text{m}$	250
				Yb:YAG	1,03 $\mu\text{m}$	250
				Yb:LuAG	1,03 $\mu\text{m}$	185
				Yb:KGW	1,035 $\mu\text{m}$	185

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



Cr<sup>4+</sup>:YAG crystals are ideal for passive Q-switch operation of Nd:YAG and other Nd<sup>3+</sup> or Yb<sup>3+</sup> doped laser crystals in the wavelength range of 900 nm to 1200 nm. Remarkable feature of Cr<sup>4+</sup>:YAG is the high damage threshold of >10 J/cm<sup>2</sup>@1064 nm, 10 ns. Its absorption band extends from 900 nm to 1200 nm and peaks around 1020 nm - 1070 nm with a very large absorption cross-section.

Herewith:

- $\sigma_{gsa}^{(1)}$  – ground-state absorption cross-section
- $\sigma_{gsa}^{(2)}$  – excited-state absorption cross-section
- $\tau_{sa}^{(3)}$  – recovery time
- $\sigma_{em}^{(4)}$  – emission cross-section

## Standard products

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



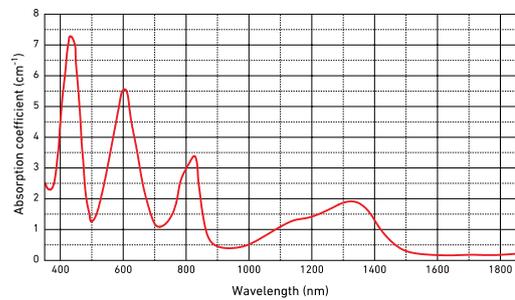
# V:YAG

## 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 5-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

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<sub>4</sub> 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.

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES						
Material	$\sigma_{gs}^{(1)}$ @1,34 $\mu\text{m}$	$\sigma_{esa}^{(2)}$ @1,34 $\mu\text{m}$	$\tau_{sa}^{(3)}$	Laser crystal	$\lambda_{laser}$	$\sigma_{gs}^{(1)}/\sigma_{em}^{(4)}$
V <sup>2+</sup> :Y <sub>3</sub> Al <sub>5</sub> O <sub>13</sub>	72 × 10 <sup>19</sup> cm <sup>2</sup>	7,4 × 10 <sup>-19</sup> cm <sup>2</sup>	5-37 ns	Pr:YAP	0,747 $\mu\text{m}$	10
				Ti:Al <sub>2</sub> O <sub>3</sub>	0,78 $\mu\text{m}$	25
				Cr:LiCAF	0,78 $\mu\text{m}$	80
				Nd:GGG	0,93 $\mu\text{m}$	-
				Nd:YLF	1,05 $\mu\text{m}$	15
				Nd:YAG	1,06 $\mu\text{m}$	8
				Nd:YVO <sub>4</sub>	1,06 $\mu\text{m}$	1,5
				Yb:KYW	1,035 $\mu\text{m}$	70
				Nd:YAP	1,34 $\mu\text{m}$	24
				Nd:GdVO <sub>4</sub>	1,34 $\mu\text{m}$	30
				Erglass	1,54 $\mu\text{m}$	45

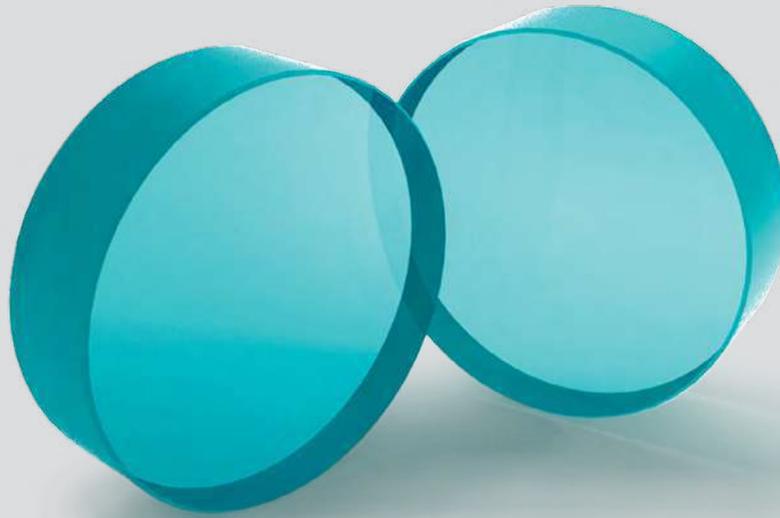
Crystal structure	Cubic
Density	4,56 g/cm <sup>3</sup>
Thermal expansion coefficient	6,14 × 10 <sup>-6</sup> K <sup>-1</sup>
Thermal conductivity	11,2 Wm <sup>-1</sup> K <sup>-1</sup>
Mohs hardness	8,2
Refractive index	1,82@1064 nm

Herewith:

- $\sigma_{gs}^{(1)}$  – ground-state absorption cross-section
- $\sigma_{esa}^{(2)}$  – excited-state absorption cross-section
- $\tau_{sa}^{(3)}$  – recovery time
- $\sigma_{em}^{(4)}$  – emission cross-section

## Standard products

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



# Co:Spinel crystals

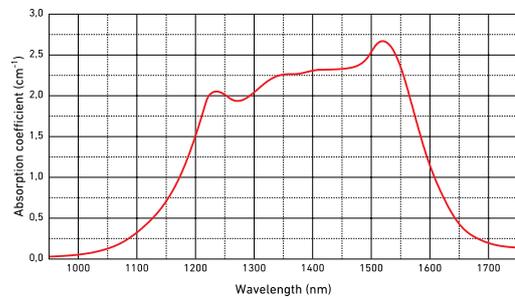
## Main features

- Low optical losses in the wavelength range of 1,3  $\mu\text{m}$  - 1,6  $\mu\text{m}$
- High laser induced damage threshold
- Custom crystals available upon request

## Application examples

- Passive Q-switch for Er:Glass lasers @1,54  $\mu\text{m}$

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  $\mu\text{m}$  - 1,6  $\mu\text{m}$ . 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.



## Standard specifications

CO:SPINEL CRYSTALS	
Available initial $T_{90}$ transmission	50-99 %@1535 nm
Initial transmission $T_{90}$ tolerance	$\pm 1\%$ (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	< $\lambda/8$ @632,8 nm
Wavefront distortion	< $\lambda/4$ @632,8 nm
Coatings	AR(R<0,15%)@1535 nm
Laser induced damage threshold	>8 J/cm <sup>2</sup> @1535 nm, 10 ns
Mount	Unmounted

## Properties

SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES						
Material	$\sigma_{gs}^{(1)}$ @1,54 $\mu\text{m}$	$\sigma_{es}^{(2)}$ @1,54 $\mu\text{m}$	$\tau_{sa}^{(3)}$	Laser crystal	$\lambda_{laser}$	$\sigma_{gs}^{(1)}/\sigma_{em}^{(4)}$
Co <sup>2+</sup> :MgAl <sub>2</sub> O <sub>4</sub>	$3,5 \times 10^{-19} \text{ cm}^2$	$0,1 \times 10^{-19} \text{ cm}^2$	220-350 ns	Nd:YAP	1,34 $\mu\text{m}$	1,5
				Nd:KGW	1,35 $\mu\text{m}$	4
				Nd:YAG	1,44 $\mu\text{m}$	12
				Er:glass	1,54 $\mu\text{m}$	40
Crystal structure	Cubic					
Density	3,58 g/cm <sup>3</sup>					
Thermal expansion coefficient	$6,14 \times 10^{-6} \text{ K}^{-1}$					
Thermal conductivity	17 Wm <sup>-1</sup> K <sup>-1</sup>					
Mohs hardness	8					
Refractive index	1,6-1,75					

Herewith:

$\sigma_{gs}^{(1)}$  – ground-state absorption cross-section

$\sigma_{es}^{(2)}$  – excited-state absorption cross-section

$\tau_{sa}^{(3)}$  – recovery time

$\sigma_{em}^{(4)}$  – emission cross-section

**Standard products**

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



# 激光器晶体

非线性晶体

**Nonlin  
cryst**

# near als



BBO crystals



LBO crystals



KTP crystals



KDP, DKDP crystals



Lithium niobate crystals



AgGaSe<sub>2</sub> crystals



AgGaS<sub>2</sub> crystals



ZnGeP<sub>2</sub> crystals



CdSe crystals



GaSe crystals



# BBO crystals

## Main features

- Broad transparency range 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

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.

## 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 <sup>2</sup> @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 <sub>2</sub> O <sub>6</sub>
Crystal structure	Rhombohedral, 3m
Lattice parameters	a=12,532 Å, c=12,717 Å
Optical symmetry	Negative uniaxial (n <sub>o</sub> >n <sub>e</sub> )
Density	3,85 g/cm <sup>3</sup>
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 <sub>o</sub> = 1,6551, n <sub>e</sub> = 1,5426 @1064 nm

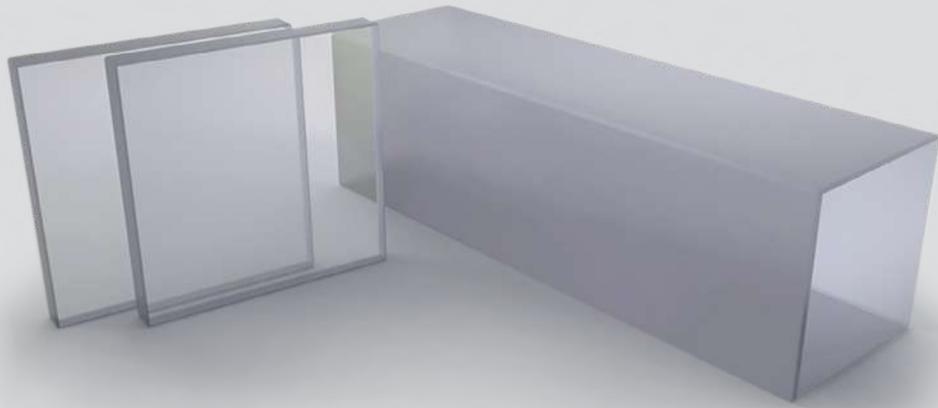
## Guidance

Optogama 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
6 x 6 mm	0,1 mm	50°	90°	P/P@515/257 nm	SHG@515 nm, 50 fs, type I	15808
	0,15 mm	50°	90°	P/P@515/257 nm	SHG@515 nm, 100 fs, type I	15809
	0,3 mm	50°	90°	P/P@515/257 nm	SHG@515 nm, 200 fs, type I	15810
	0,05 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 10 fs, type I	15811
	0,1 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 20 fs, type I	6399
	0,2 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 50 fs, type I	15833
	0,5 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 100 fs, type I	6398
	1 mm	29,2°	90°	P/P@400-800 nm	SHG@800 nm, 200 fs, type I	6400
	0,5 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 50 fs, type I	9447
	1 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 100 fs, type I	9448
	1,5 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 150 fs, type I	9449
	2 mm	23,4°	90°	AR/AR@515+1030 nm	SHG@1030 nm, 200 fs, type I	10733
	0,01 mm	44,3°	90°	P/P@400-800/266 nm	THG@800 nm, 10 fs, type I	15834
	0,02 mm	44,3°	90°	P/P@400-800/266 nm	THG@800 nm, 20 fs, type I	15835
	0,05 mm	44,3°	90°	P/P@400-800/266 nm	THG@800 nm, 50 fs, type I	15836
	0,1 mm	44,3°	90°	P/P@400-800/266 nm	THG@800 nm, 100 fs, type I	9044
	0,2 mm	44,3°	90°	P/P@400-800/266 nm	THG@800 nm, 200 fs, type I	15837
	0,15 mm	32,5°	90°	AR/AR@515+1030/343 nm	THG@1030 nm, 50 fs, type I	9450
	0,25 mm	32,5°	90°	AR/AR@515+1030/343 nm	THG@1030 nm, 100 fs, type I	9451
	0,55 mm	32,5°	90°	AR/AR@515+1030/343 nm	THG@1030 nm, 200 fs, type I	9452

# LBO crystals



## 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
- Custom size, orientation and coatings are available upon

## 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,  $t = 149^\circ\text{C}$ )

Lithium Triborate (LiB<sub>3</sub>O<sub>5</sub>, 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.

## 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	<N/4@632,8 nm
Coatings	AR coatings on both sides
Laser induced damage threshold	>1 GW/cm <sup>2</sup> @1064 nm, 10 ns
Mount	Unmounted

## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	LiB <sub>3</sub> O <sub>5</sub>
Crystal structure	Orthorhombic, mm <sup>2</sup>
Lattice parameters	a = 8,46 Å, b = 7,38 Å, c = 12,717 Å
Optical symmetry	Negative biaxial (2V <sub>x</sub> = 109,2° @0,5321 μm)
Density	2,474 g/cm <sup>3</sup>
Mohs hardness	6-7
Transparency range	155 nm - 3,2 μm @0° transmittance level
Sellmeier equations @T = 293 K (λ in μm)	$n_x^2 = 2,4542 + 0,01125/(\lambda^2 - 0,01135) - 0,01388 \lambda^2$ $n_y^2 = 2,5390 + 0,01277/(\lambda^2 - 0,01189) - 0,01849 \lambda^2$ $+ 4,3025 \times 10^{-5} \lambda^4 - 2,9131 \times 10^{-5} \lambda^6$ $n_z^2 = 2,5865 + 0,0131/(\lambda^2 - 0,01223) - 0,01862 \lambda^2 + 4,5778 \times 10^{-5} \lambda^4 - 3,2526 \times 10^{-5} \lambda^6$
Refractive indices	$n_x = 1,5656$ ; $n_y = 1,5905$ ; $n_z = 1,6055$ @1064 nm

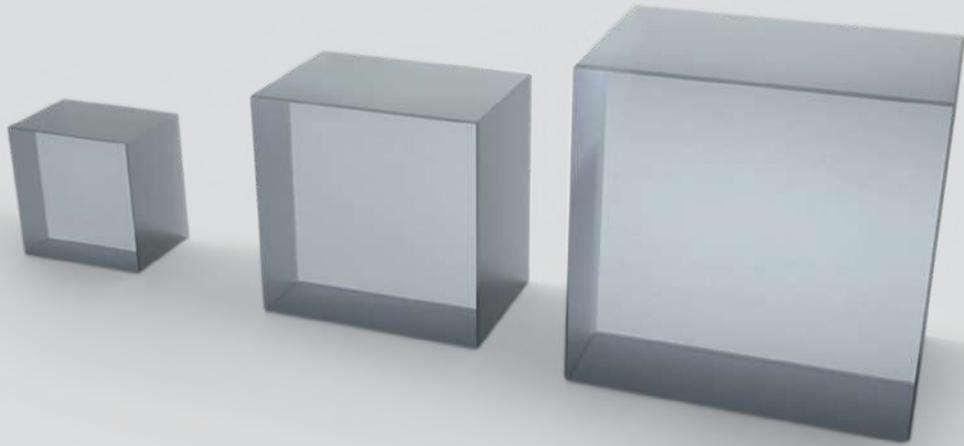
## Guidance

Optogama 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
3 x 3 mm	10 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7203
	10 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	7199
	10 mm	90°	0°	AR/AR@532+1064 nm	NCPM SHG@1064 nm, T = 149 °C	7209
	20 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7202
	20 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	9457
	20 mm	90°	0°	AR/AR@532+1064 nm	NCPM SHG@1064 nm, T = 149 °C	7210
5 x 5 mm	10 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7207
	10 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	7204
	20 mm	90°	11,6°	AR/AR@532+1064 nm	SHG@1064 nm, type I	7208
	20 mm	42,2°	90°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	9459
6 x 6 mm	1 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9458
	2 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9460
	3 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9461
	4 mm	90°	13,8°	AR/AR@515+1030 nm	SHG@1030 nm, type I	9462

# KTP crystals



## Main features

- High nonlinearity
- Nonhygroscopic crystal
- Great mechanical stability
- Wide transparency range from 350 nm to 4,5  $\mu\text{m}$
- 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

Potassium titanyl phosphate ( $\text{KTiOPO}_4$ , KTP) crystals are advantageous due to their high nonlinearity, great mechanical stability, high optical quality and transparency range of 350 nm - 4,5  $\mu\text{m}$ . 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  $\mu\text{m}$  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. Optogama 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.

## Standard specifications

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

## Properties

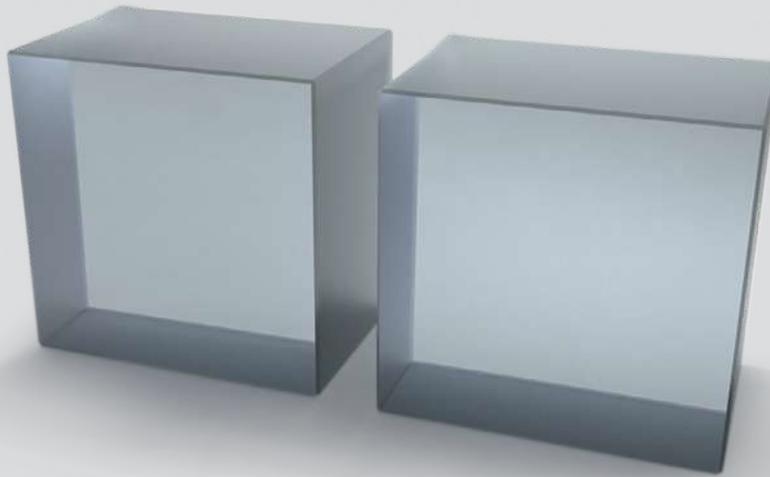
PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$\text{KTiOPO}_4$
Crystal structure	Orthorhombic, mm <sup>2</sup>
Lattice parameters	a = 12,814 Å, b = 6,404 Å, c = 10,616 Å
Optical symmetry	Positive biaxial ( $2V_z = 37,4^\circ$ @0,5461 $\mu\text{m}$ )
Density	2,945 g/cm <sup>3</sup>
Mohs hardness	5
Transparency range	350 nm - 4,5 $\mu\text{m}$ @"0" transmittance level
Sellmeier equations ( $\lambda$ in $\mu\text{m}$ )	$n_x^2 = 3,0067 + 0,0395/\lambda^2 - 0,04251$ $n_y^2 = 3,0319 + 0,04152/\lambda^2 - 0,04586$ $n_z^2 = 3,3134 + 0,05694/\lambda^2 - 0,05941$ - 0,016713 $\lambda^2$
Refractive indices	$n_x = 1,7404$ ; $n_y = 1,7479$ ; $n_z = 1,8296$ @1064 nm

## Guidance

Optogama 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	COATINGS	APPLICATION	SKU
3 x 3 mm	5 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7184
	10 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7188
5 x 5 mm	5 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7189
	10 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7193
7 x 7 mm	5 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7194
	10 mm	90°	23,5°	AR/AR@532+1064 nm	SHG@1064 nm, type II	7198



# KDP, DKDP crystals

## Main features

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

## Application examples

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

Potassium dihydrogen phosphate ( $\text{KH}_2\text{PO}_4$ , KDP) and potassium dideuterium phosphate ( $\text{KD}_2\text{PO}_4$ , 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, but these crystals can be grown in large size. They found their application as nonlinear frequency doublers, triplers and quadruplers 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 must be ensured.

## Standard specifications

KDP, 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/cm <sup>2</sup> @1064 nm, 10 ns for KDP crystals >5 J/cm <sup>2</sup> @1064 nm, 10 ns for DKDP
Mount	Unmounted

## Properties

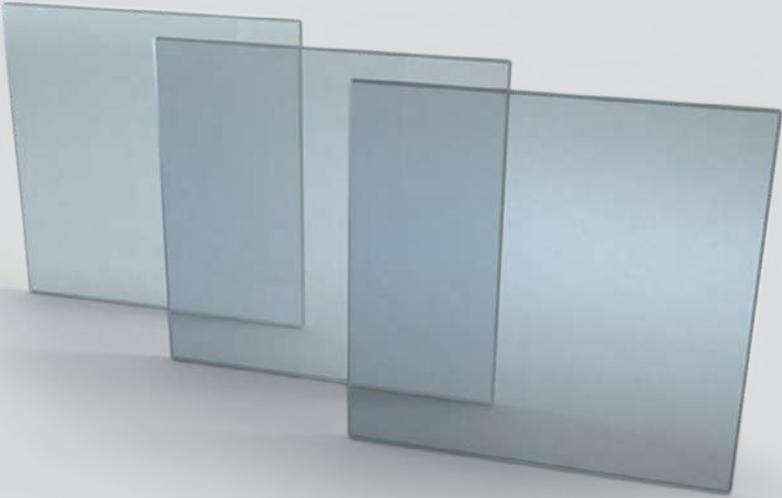
PHYSICAL AND OPTICAL PROPERTIES		
Chemical formula	$\text{KH}_2\text{PO}_4$ (KDP)	$\text{KD}_2\text{PO}_4$ (DKDP)
Crystal structure	Tetragonal, 42m	Tetragonal, 42m
Lattice parameters	a = 7,448 Å, c = 6,977 Å	a = 7,4697 Å, c = 6,966 Å
Optical symmetry	Negative uniaxial ( $n_o > n_e$ )	Negative uniaxial ( $n_o > n_e$ )
Density	2,332 g/cm <sup>3</sup>	2,355 g/cm <sup>3</sup>
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)	$n_o^2 = 2,259276 + 13,00522 \lambda^2 / (\lambda^2 - 400) + 0,01008956 / (\lambda^2 - (77,26408)^2)$ $n_e^2 = 2,132668 + 3,2279924 \lambda^2 / (\lambda^2 - 400) + 0,008637494 / (\lambda^2 - (81,42631)^2)$	
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

Optogama 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
KDP	12 x 12 mm	5 mm	76,5°	45°	AR/AR@532/266 nm	SHG@532 nm, type I	9421
	15 x 15 mm	7 mm	76,5°	45°	AR/AR@532/266 nm	SHG@532 nm, type I	9422
	12 x 12 mm	20 mm	53,5°	0°	AR/AR@1064/532+1064 nm	SHG@1064 nm, type II	9426
	12 x 12 mm	20 mm	59,3°	0°	AR/AR@1064/532+1064 nm	THG@1064 nm, type II	9425
DKDP	15 x 15 mm	13 mm	36,5°	45°	AR/AR@532+1064 nm	SHG@1064 nm, type I	9423
	15 x 15 mm	13 mm	53,5°	0°	AR/AR@532+1064 nm	SHG@1064 nm, type II	9424
	15 x 15 mm	20 mm	53,5°	0°	AR/AR@1064/532+1064 nm	SHG@1064 nm, type II	9427
	15 x 15 mm	20 mm	59,3°	0°	AR/AR@532+1064/355 nm	THG@1064 nm, type II	9428



# Lithium niobate crystals

## 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

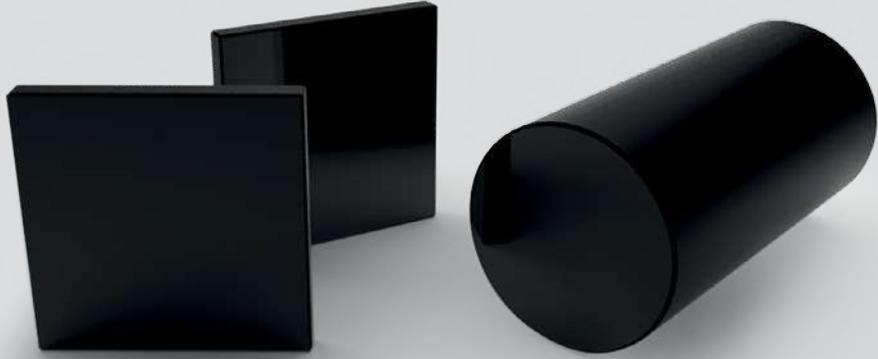
- Electro-optic modulation and Q-switching
- Optical parametric oscillators (OPO) pumped at 1064 nm
- Quasi-phase-matched devices with periodically poled lithium niobate (PPLN)

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

Lithium niobate ( $\text{LiNbO}_3$ , LN) is a multi-purpose material in photonics and optoelectronics fields. It features a wide transparency range from 420 nm to 5,2  $\mu\text{m}$ , excellent nonlinear, electro-optic, and piezoelectric properties. Most common applications include infrared range optical modulation and Q-switching, nonlinear frequency conversion of  $>1 \mu\text{m}$  wavelengths. Their electrical and optical properties can be adjusted using magnesium or zirconium dopants.

## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$\text{LiNbO}_3$
Crystal structure	Trigonal, 3m
Optical symmetry	Negative uniaxial ( $n_e > n_o$ )
Density	4,64 g/cm <sup>3</sup>
Mohs hardness	5
Transparency range	420 nm - 5,2 $\mu\text{m}$
Sellmeier equations ( $\lambda$ in $\mu\text{m}$ )	$n_o^2 = 4,9048 + 0,11768/\lambda^2 - 0,04750 - 0,027169 \lambda^2$ $n_e^2 = 4,5820 + 0,099169/\lambda^2 - 0,04443 - 0,021950 \lambda^2$
Refractive indices	$n_o = 2,220$ ; $n_e = 2,146$ @1064 nm



# CdSe crystals

## Main features

- Wide transparency range (0,7-24  $\mu\text{m}$ )
- Reasonably large nonlinearity
- Small walk-off angle

## Application examples

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

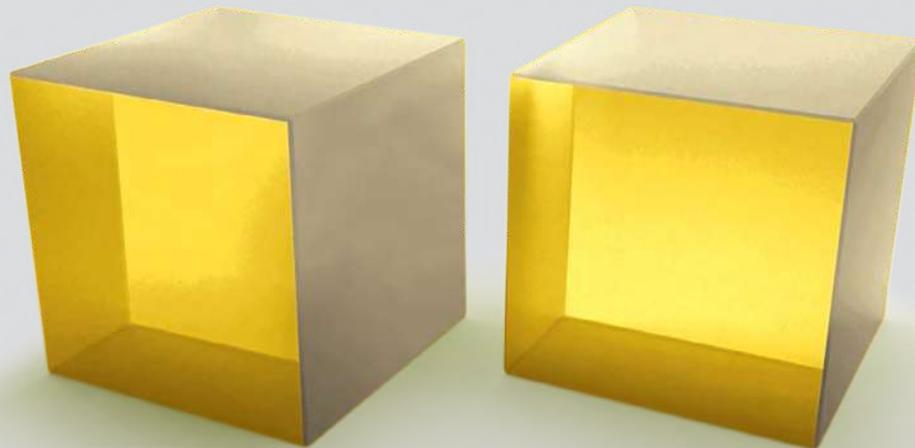
Optogama does not provide standard product list. Please contact us for solutions and pricing.

Cadmium selenide (CdSe) crystals feature an infrared transmission up to 24  $\mu\text{m}$ , 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 ( $>12 \mu\text{m}$ ). For instance, CdSe OPO can potentially be pumped by 2  $\mu\text{m}$  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 and other.

## Properties

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

# AgGaS<sub>2</sub> crystals



## Main features

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

## Application examples

- Frequency mixing in the middle IR region up to ~12 μm
- Second harmonic generation and up-conversion for CO<sub>2</sub> lasers
- Tunable OPO for solid-state lasers

Silver Thiogallate (AgGaS<sub>2</sub>, AGS) has been demonstrated as an efficient crystal for nonlinear parametric applications in the infrared spectral range. Its transparency region spans from 0,53 μm 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<sub>2</sub> 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). AGS crystal features high non-linear coefficient, high damage threshold, low optical absorption and scattering.

## Standard specifications

AgGaS <sub>2</sub> 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 <sub>2</sub>
Crystal structure	Tetragonal, 42m
Lattice parameters	a = 5,742 Å, c = 10,26 Å
Optical symmetry	Negative uniaxial (n <sub>x</sub> > n <sub>y</sub> , λ < 0,497 μm n <sub>z</sub> > n <sub>y</sub> )
Density	4,58 g/cm <sup>3</sup>
Mohs hardness	3-3,5
Transparency range	0,47 - 13 μm @ "0" transmittance level
Sellmeier equations @ T = 293 K (λ in μm)	n <sub>x</sub> <sup>2</sup> = 5,79419 + 0,23114/(λ <sup>2</sup> - 0,06882) - 2,4534 × 10 <sup>-3</sup> λ <sup>2</sup> + 3,1814 × 10 <sup>-7</sup> λ <sup>4</sup> - 9,7051 × 10 <sup>-9</sup> λ <sup>6</sup> ; n <sub>y</sub> <sup>2</sup> = 5,54120 + 0,22041/(λ <sup>2</sup> - 0,09824) - 2,5240 × 10 <sup>-3</sup> λ <sup>2</sup> + 3,6214 × 10 <sup>-7</sup> λ <sup>4</sup> - 8,3605 × 10 <sup>-9</sup> λ <sup>6</sup>
Refractive indices	n <sub>x</sub> = 2,3471; n <sub>y</sub> = 2,2914 @ 10,6321 μm
Thermal conductivity	1,4 (llc) Wm <sup>-1</sup> K <sup>-1</sup> , 1,5 (Lc) Wm <sup>-1</sup> K <sup>-1</sup>

## Guidance

Optogama provides guidance and theoretical calculations for particular AgGaS<sub>2</sub> applications. Contact us and we will help you to configure your crystal.

## Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU
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
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
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
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



# AgGaSe<sub>2</sub> crystals

## Main features

- Excellent properties across the transmission range from 0,73 to 18  $\mu\text{m}$
- 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  $\sim 18,3 \mu\text{m}$
- Second harmonic generation and up-conversion for CO<sub>2</sub> lasers
- Tunable OPO for solid-state lasers

Silver gallium selenide (AgGaSe<sub>2</sub>, AGSe) is an optically negative uniaxial crystal with a reasonable transmittance over  $\sim 0,7 \mu\text{m} - 18 \mu\text{m}$  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. AGSe crystal has high figure of merit ( $\sim 70 \text{ pm}^2/\text{V}^2$ ,  $n \sim 2,6$ ), which is six times larger than counterpart AGS. For some 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 ( $\sim 2-12 \mu\text{m}$ ) is no match to AGSe.

## Standard specifications

AgGaSe <sub>2</sub> 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 $\mu\text{m}$ /5-18 $\mu\text{m}$
Mount	Unmounted

## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	AgGaSe <sub>2</sub>
Crystal structure	Tetragonal, 42m
Lattice parameters	a = 5,9920 Å, c = 10,8803 Å
Optical symmetry	Negative uniaxial ( $n_o > n_e$ , $\lambda < 804 \text{ nm}$ , $n_o > n_e$ )
Density	5,7 g/cm <sup>3</sup>
Mohs hardness	3-3,5
Transparency range	0,71 - 19 $\mu\text{m}$ @'0' transmittance level
Sellmeier equations @T=293 K ( $\lambda$ in $\mu\text{m}$ )	$n_o^2 = 6,8507 + 0,4297/(\lambda^2 - 0,1584) - 0,00125 \lambda^2$ $n_e^2 = 6,6792 + 0,4598/(\lambda^2 - 0,2122) - 0,00126 \lambda^2$
Refractive indices	$n_o = 2,5917$ ; $n_e = 2,5585$ @10,5 $\mu\text{m}$
Thermal conductivity @T = 293 K	1 (llc) Wm <sup>-1</sup> K <sup>-1</sup> , 1,1 (Lc) Wm <sup>-1</sup> K <sup>-1</sup>
Laser induced damage threshold	>10 MW/cm <sup>2</sup> @10,6 $\mu\text{m}$ , 150 ns

## Guidance

Optogama provides guidance and theoretical calculations for particular AgGaSe<sub>2</sub> applications. Contact us and we will help you to configure your crystal.

## Standard products

FACE DIMENSIONS	LENGTH	THETA	PHI	COATINGS	APPLICATION	SKU
5 x 5 mm	2 mm	52°	45°	BBAR@1,7-2,7 $\mu\text{m}$ /BBAR@5-18 $\mu\text{m}$	Ultrashort pulse DFG@1,7-2,7 $\mu\text{m}$ -> $\sim 5-18 \mu\text{m}$ , type I	15806
	5 mm	52°	45°	BBAR@1,7-2,7 $\mu\text{m}$ /BBAR@5-18 $\mu\text{m}$	Ultrashort pulse DFG@1,7-2,7 $\mu\text{m}$ -> $\sim 5-18 \mu\text{m}$ , type I	15807
	10 mm	52°	45°	BBAR@1,7-2,7 $\mu\text{m}$ /BBAR@5-18 $\mu\text{m}$	Ultrashort pulse DFG@1,7-2,7 $\mu\text{m}$ -> $\sim 5-18 \mu\text{m}$ , type I	15805

# ZnGeP<sub>2</sub> crystals



## Main features

- The transmission range spans from 0,74 μm to 12 μm
- High nonlinearity (75 pm/V)
- High thermal conductivity (35 W/mK)
- Nominal absorption coefficient <0,04 cm<sup>-1</sup> at ~2,1 μm for o-wave

## Application examples

- Mid-IR OPOs pumped at ~2,1 μm
- Generation of terahertz range frequencies

Zinc Germanium Phosphide (ZnGeP<sub>2</sub>, ZGP) crystals feature a combination of high nonlinearity, high thermal conductivity and a wide transmission range from 0,74 to 12 μm. These crystals gained credit for their role of ~2,1 μm pumped optical parametric oscillators (OPOs) spanning the spectral range from 2 to 8 μm.

## Standard specifications

ZnGeP <sub>2</sub> 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 <sup>-1</sup> @2,1 μm, o-wave
Mount	Unmounted

## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	ZnGeP <sub>2</sub>
Crystal structure	Tetragonal, 42m
Lattice parameters	a = 5,465 Å, c = 10,708 Å
Optical symmetry	Positive uniaxial (n <sub>e</sub> > n <sub>o</sub> )
Density	4,162 g/cm <sup>3</sup>
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 <sub>o</sub> <sup>2</sup> = 11,6413 + 0,69363/(λ <sup>2</sup> - 0,21967) + 1586,06/(λ <sup>2</sup> - 832,75); n <sub>e</sub> <sup>2</sup> = 12,1438 + 0,75255/(λ <sup>2</sup> - 0,21913) + 2061,68/(λ <sup>2</sup> - 951,07)
Refractive indices	n <sub>o</sub> = 3,0738; n <sub>e</sub> = 3,1137 @10,5 μm
Thermal conductivity @T = 293 K	36 (llc) Wm <sup>-1</sup> K <sup>-1</sup> , 35 (Lc) Wm <sup>-1</sup> K <sup>-1</sup>
Laser induced damage threshold	60 MW/cm <sup>2</sup> @10,6 μm, 100 ns

## Guidance

Optogama provides guidance and theoretical calculations for particular ZnGeP<sub>2</sub> applications. Contact us and we will help you to configure your crystal.

## Standard products

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



# GaSe crystals

## Main features

- Broad transparency range from 0,65  $\mu\text{m}$  to 18  $\mu\text{m}$
- 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  $\text{CO}_2$ , CO, dye lasers
- Terahertz (THz) generation by optical rectification
- Terahertz detectors for terahertz time domain spectroscopy (THz-TDS)

Optogama 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.

## Standard specifications

GaSe crystals	
Clear aperture	$\geq \varnothing 7$ mm or custom
Surface quality	Cleaved surfaces
Coatings	Uncoated, unavailable
Mount	$\varnothing 25,4$ mm black anodized aluminum mount

## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	GaSe
Crystal structure	Hexagonal, -62m
Lattice parameters	$A = 3,742 \text{ \AA}$ , $c = 15,918 \text{ \AA}$
Optical symmetry	Negative uniaxial (no>ne)
Density	5,03 g/cm <sup>3</sup>
Mohs hardness	$\approx 0$
Transparency range	0,62-20 $\mu\text{m}$ @ "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 $\mu\text{m}$

## Guidance

Optogama 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
$\geq \varnothing 7$ mm	0,2 mm	z-cut	Uncoated	31313
	0,5 mm	z-cut	Uncoated	31124
	1 mm	z-cut	Uncoated	31126
	2 mm	z-cut	Uncoated	31127



# 激光器晶体

拉曼晶体

# Raman crystal

# an als



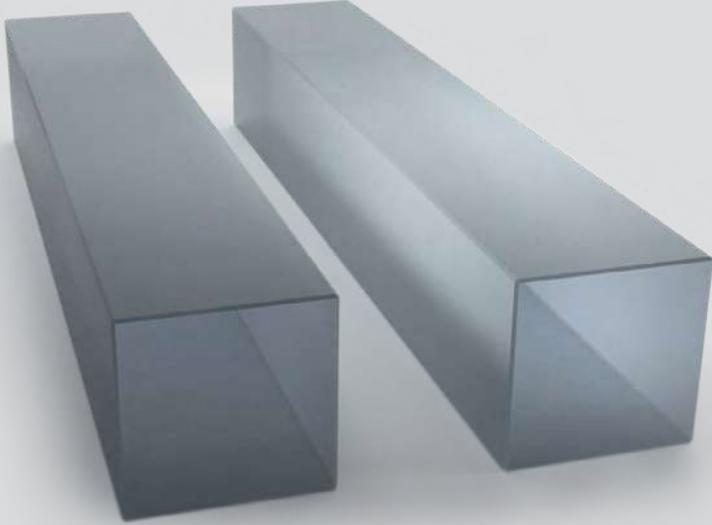
Barium nitrate  
crystals



KGW crystals



KYW crystals



# Barium nitrate crystals

## Main features

- Transparency range from 350 nm to 1800 nm
- Raman frequency shift of 1048  $\text{cm}^{-1}$
- 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  $\mu\text{m}$  "eye-safe" radiation, which coincides with  $\text{CO}_2$  absorption line

Barium nitrate ( $\text{Ba}(\text{NO}_3)_2$ ) 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 ( $g_R = 47 \text{ cm/GW@532 nm}$  pump). Barium nitrate also features a moderately broad transparency range (0,33  $\mu\text{m}$  - 1,8  $\mu\text{m}$ ) and high damage threshold. Drawbacks of barium nitrate crystal are low thermal conductivity (1,17  $\text{Wm}^{-1}\text{K}^{-1}$ ) and high thermo-optic coefficient ( $dn/dT = -20 \times 10^{-6}\text{K}^{-1}$ ), which lead to the thermal lensing effect. The crystal is soft and hygroscopic, therefore should be treated with caution. Optogama recommend using barium nitrate as a Raman shifter for nanosecond applications.

## Standard specifications

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

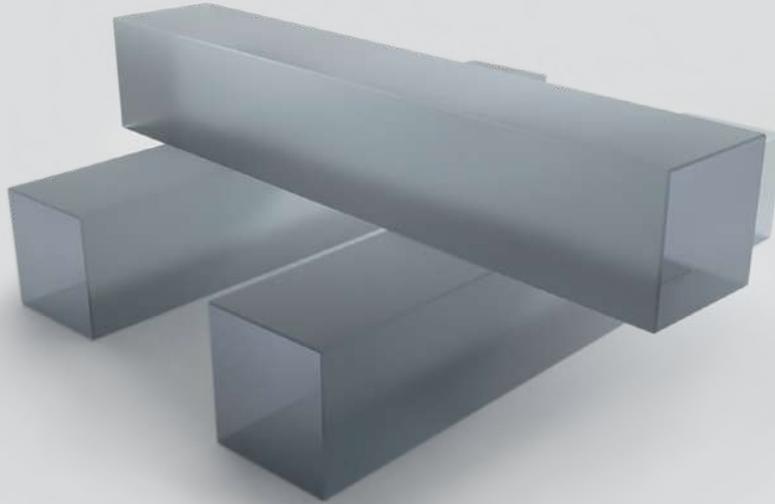
## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$\text{Ba}(\text{NO}_3)_2$
Crystal structure	Cubic, $P2_13$
Lattice parameters	$a = b = c = 8,11 \text{ \AA}$
Density	3,25 $\text{g/cm}^3$
Mohs hardness	2,5-3
Transparency range	0,33 $\mu\text{m}$ - 1,8 $\mu\text{m}$
Refractive index	1,555@1064 nm
Thermal conductivity	1,17 $\text{Wm}^{-1}\text{K}^{-1}$ @llc
Thermal expansion coefficient	$13 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$
dn/dT	$-20 \times 10^{-6}\text{K}^{-1}$
Raman frequency shift	1047 $\text{cm}^{-1}$
Raman linewidth	0,4 $\text{cm}^{-1}$
Raman gain (ns, steady-state regime)	47 $\text{cm/GW@532 nm}$ 11 $\text{cm/GW@1064 nm}$
Dephasing time	28 ps

## Standard products

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

Minimum order quantity: 2 pieces.



# KGW crystals

## Main features

- Broad transparency range from 300 nm to 5  $\mu\text{m}$
- Two pump polarization-dependent Raman shifts at 768  $\text{cm}^{-1}$  and 901  $\text{cm}^{-1}$
- 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

Potassium gadolinium tungstate ( $\text{KGd}(\text{WO}_4)_2$ , KGW) crystals feature good mechanical properties, relatively good thermal conductivity ( $2,5\text{-}3,4 \text{ Wm}^{-1}\text{K}^{-1}$ ) and wide transparency range, which spans from 350 nm to 5  $\mu\text{m}$ . KGW as a Raman crystal features two large Raman modes at 768  $\text{cm}^{-1}$  and 901  $\text{cm}^{-1}$ , which are pump polarization dependent. Optogama recommend using KGW crystal as a Raman shifter for picosecond applications.

## Standard specifications

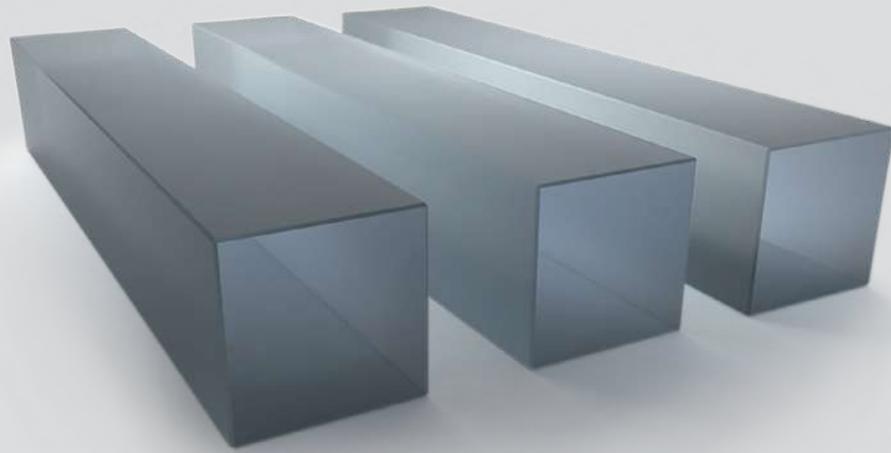
KGW CRYSTALS	
Orientation	b-cut
Clear aperture	>90%
Face dimensions tolerance	+0,0/-0,1 mm
Length tolerance	$\pm 0,1$ mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	< $\lambda/8$ @632,8 nm
Wavefront distortion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

## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$\text{KGd}(\text{WO}_4)_2$
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 <sup>3</sup>
Mohs hardness	4-5
Transparency range	0,3 $\mu\text{m}$ - 5 $\mu\text{m}$
Refractive indices@1064 nm	$n_o = 1,982$ $n_e = 2,010$ $n_g = 2,061$
Thermal conductivity	$K_x = 2,6 \text{ Wm}^{-1}\text{K}^{-1}$ $K_y = 3,8 \text{ Wm}^{-1}\text{K}^{-1}$ $K_z = 3,4 \text{ Wm}^{-1}\text{K}^{-1}$
dn/dT	$dn_o/dT = -15,7 \times 10^{-6} \text{K}^{-1}$ $dn_e/dT = -11,8 \times 10^{-6} \text{K}^{-1}$ $dn_g/dT = -17,3 \times 10^{-6} \text{K}^{-1}$
Raman frequency shift	901 $\text{cm}^{-1}$ (p[mm]p), 767 $\text{cm}^{-1}$ (p[gg]p)
Raman linewidth	5,4 $\text{cm}^{-1}$ @901 $\text{cm}^{-1}$ (p[mm]p) 6,4 $\text{cm}^{-1}$ @767 $\text{cm}^{-1}$ (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
5 x 5 mm	15 mm	Uncoated	7259
		AR/AR@450-800 nm	7262
	30 mm	Uncoated	7260
		AR/AR@450-800 nm	7263
	45 mm	Uncoated	7261
		AR/AR@450-800 nm	7264
	50 mm	Uncoated	22033
		AR/AR@450-800 nm	11429



# KYW crystals

## Main features

- Broad transparency range from 350 nm to 5,5  $\mu\text{m}$
- Two large Raman shifts of 765  $\text{cm}^{-1}$  and 905  $\text{cm}^{-1}$

## Application examples

- Raman lasers
- Radiation frequency tuning

Potassium yttrium tungstate ( $\text{KY}(\text{WO}_4)_2$ , KYW) crystals offer two strong phonon modes around 765  $\text{cm}^{-1}$  and 905  $\text{cm}^{-1}$ , 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  $\mu\text{m}$ ) and thermal conductivity around three times higher than barium nitrate.

## Standard specifications

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

## Properties

PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$\text{KY}(\text{WO}_4)_2$
Crystal structure	Monoclinic, C2/c
Lattice parameters	a = 10,64 Å, b = 10,32 Å, c = 7,55 Å
Density	6,61 g/cm <sup>3</sup>
Mohs hardness	4-5
Transparency range	0,35-5,5 $\mu\text{m}$
Refractive indices (1064 nm, room temperature)	$n_o = 1,9688$ $n_m = 2,0065$ $n_e = 2,0507$
Thermal conductivity (average value)	3,3 Wm <sup>-1</sup> K <sup>-1</sup>
dn/dT	$dn_o/dT = -14,6 \times 10^{-6} \text{ K}^{-1}$ $dn_m/dT = -8,9 \times 10^{-6} \text{ K}^{-1}$ $dn_e/dT = -12,4 \times 10^{-6} \text{ K}^{-1}$
Raman frequency shift (T = 300 K)	905 $\text{cm}^{-1}$ (E IN <sub>z</sub> ) 765 $\text{cm}^{-1}$ (E IN <sub>z</sub> )
Raman gain (1064 nm pump, steady-state regime)	3,6 cm/GW

## Standard products

FACE DIMENSIONS	LENGTH	COATINGS	SKU
5 x 5 mm	15 mm	Uncoated	7273
		AR/AR@450-800 nm	7276
	30 mm	Uncoated	7274
		AR/AR@450-800 nm	7277
	45 mm	Uncoated	7275
		AR/AR@450-800 nm	7278
	50 mm	Uncoated	31051
		AR/AR@450-800 nm	31052



# Photo fracti cryst

激光器晶体

光折变晶体

# ore- ive als



BSO crystals



Fe:LiNbO<sub>3</sub> crystals



SBN crystals



BGO crystals

# BSO crystals

## Main features

- High electro-optic coefficient ( $r_{41} = 5 \text{ pm/V}$ )
- 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

Bismuth silicone oxide ( $\text{Bi}_{12}\text{SiO}_{20}$ , 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.

## Standard specifications

BSO CRYSTALS	
Clear aperture	85%
Face dimensions tolerance	+0.1/-0.25 mm
Thickness tolerance	$\pm 0.2 \text{ mm}$
Parallelism error	<30 arcsec
Protective chamfers	<0.3 mm at 45°
Surface quality	40-20 S-D
Wavefront distortion	<N/4@632.8 nm
Coatings	Uncoated
Mount	Unmounted

## Properties

MAIN PROPERTIES	
Chemical formula	$\text{Bi}_{12}\text{SiO}_{20}$
Crystal structure	Cubic, point group 23
Lattice parameters	10.10 Å
Density	9.2 g/cm <sup>3</sup>
Mohs hardness	5
Transmission Range	0.45-6 $\mu\text{m}$
Refractive Index	2.54@0.63 $\mu\text{m}$
Optical Activity	42 deg/mm@500 nm
Electro-optic coefficient	$r_{41} = 5 \text{ pm/V}$
Dielectric constant (low frequency)	56
Dark resistance	$10^{14} \text{ Ohm cm}$

## Standard products

FACE DIMENSIONS	LENGTH	ORIENTATION	SKU
5 x 5 mm	5 mm	[100]	6885
	5 mm	[110]	6884
10 x 10 mm	5 mm	[100]	6883
	5 mm	[110]	6882
20 x 20 mm	1,1 mm	[100]	6881
	1,1 mm	[110]	6880
25 x 25 mm	1,1 mm	[110]	27782
30 x 30 mm	1,1 mm	[110]	1558
	1,4 mm	[110]	9095



# BGO crystals

## Main features

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

## Application examples

- Spatial light modulators
- Optical switches
- Optical correlators

Bismuth germanite ( $\text{Bi}_{12}\text{GeO}_{20}$ , 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.

## Standard specifications

BGO CRYSTALS	
Clear aperture	85%
Face dimensions tolerance	+0.1/-0.25 mm
Thickness tolerance	$\pm 0,2 \text{ mm}$
Parallelism error	<30 arcsec
Protective chamfers	<0,3 mm at 45°
Surface quality	40-20 S-D
Wavefront distortion	< $\lambda/4$ @632,8 nm
Coatings	Uncoated
Mount	Unmounted

## Properties

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

## Standard products

FACE DIMENSIONS	LENGTH	ORIENTATION	SKU
20 x 20 mm	1,1 mm	[100]	6875
	1,1 mm	[110]	6874
25 x 25 mm	1,1 mm	[110]	31146
30 x 30 mm	1,1 mm	[110]	6876
	1,4 mm	[110]	6877

# Fe:LiNbO<sub>3</sub> crystals

## Main features

- High electro-optic coefficient ( $r_{41} = 5 \text{ pm/V}$ )
- 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

Lithium niobate (LiNbO<sub>3</sub>, LN) crystal doped with iron (Fe:LiNbO<sub>3</sub>) is an attractive photorefractive material, due to the high photorefractive sensitivity, high electro-optic coefficients and diffraction efficiency, chemo-mechanical properties. Fe:LiNbO<sub>3</sub> 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<sub>3</sub> crystals are easy to handle, low cost, therefore suitable for volume production.

## Standard specifications

FE:LiNbO <sub>3</sub> CRYSTALS	
Dopant level, Fe <sub>2</sub> O <sub>3</sub>	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 <sub>3</sub>
Crystal structure	Trigonal, 3m
Density	4.64 g/cm <sup>3</sup>
Mohs hardness	5
Transmission range	0.35-5.5 μm
Refractive index @0.63 μm	$n_o = 2.20$ $n_e = 2.29$
Electro-optic coefficients	$r_{22} = 6.8 \text{ pm/V}$ $r_{31} = 10 \text{ pm/V}$ $r_{33} = 32 \text{ pm/V}$
Dielectric constant	$\epsilon_{11} = 85$ $\epsilon_{33} = 30$

## Standard products

FACE DIMENSIONS	LENGTH	DOPING	SKU
10 x 10 mm	1 mm	0.02 % Fe <sub>2</sub> O <sub>3</sub>	7006
		0.03 % Fe <sub>2</sub> O <sub>3</sub>	7007
		0.05 % Fe <sub>2</sub> O <sub>3</sub>	7008
		0.1 % Fe <sub>2</sub> O <sub>3</sub>	7009
10 x 10 mm	5 mm	0.02 % Fe <sub>2</sub> O <sub>3</sub>	6457
		0.03 % Fe <sub>2</sub> O <sub>3</sub>	6458
		0.05 % Fe <sub>2</sub> O <sub>3</sub>	4052
		0.1 % Fe <sub>2</sub> O <sub>3</sub>	7005
20 x 20 mm	1 mm	0.02 % Fe <sub>2</sub> O <sub>3</sub>	7010
		0.03 % Fe <sub>2</sub> O <sub>3</sub>	7011
		0.05 % Fe <sub>2</sub> O <sub>3</sub>	7012
		0.1 % Fe <sub>2</sub> O <sub>3</sub>	7013



# SBN crystals

## 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

Strontium-barium niobate ( $\text{Sr}_x\text{Ba}_{(1-x)}\text{Nb}_2\text{O}_6$ , 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. Optogama provide inclusion-free and homogenous SBN crystals, which are grown by Modified Stepanov method and available with linear dimensions up to 40 mm.

## 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, 80-50 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	$a = 12,46 \text{ \AA}$ , $c = 3,946 \text{ \AA}$
Density	5,4 g/cm <sup>3</sup>
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	$r_{13} = 45 \text{ pm/V}$ $r_{33} = 250 \text{ pm/V}$
Pyroelectric coefficient	0,065 μC cm <sup>-2</sup> K <sup>-1</sup>
Dielectric constant	880

## Standard products

MATERIAL	FACE DIMENSIONS	LENGTH	DOPING	SKU
SBN:61	5 x 5 mm	5 mm	Undoped	73
			CeO2 0,002 wt, %	6940
			CeO2 0,01 wt, %	6944
		10 mm	Undoped	74
			CeO2 0,002 wt, %	6941
			CeO2 0,01 wt, %	6945
		15 mm	Undoped	75
			CeO2 0,002 wt, %	6942
			CeO2 0,01 wt, %	6946



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