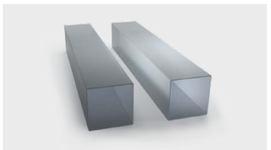
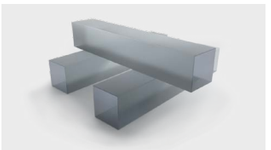
Raman crystals

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

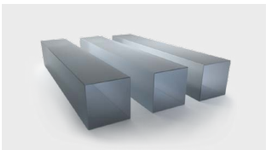
4Lasers provide barium nitrate and undoped KGW, KYW Raman crystals. Do not hesitate to request custom, if desired crystals are not present in the standard list.



Barium nitrate crystals

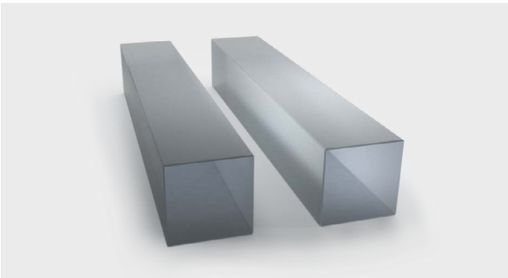


KGW crystals



KYW crystals

Barium nitrate crystals



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

Main features

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

Application examples

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

Standard specifications

BARIUM NITRATE CRYSTALS	
Orientation	[111]
Clear aperture	>90%
Face dimensions tolerance	+0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<2 arcmin
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	40-20 S-D
Surface flatness	<λ/6@632,8 nm
Wavefront distortion	<λ/4@632,8 nm
Coatings	AR(R<0,5%)@500-700 nm
Laser induced damage threshold	>10 J/cm^2@1064 nm, 10 ns
Mount	Unmounted

Properties

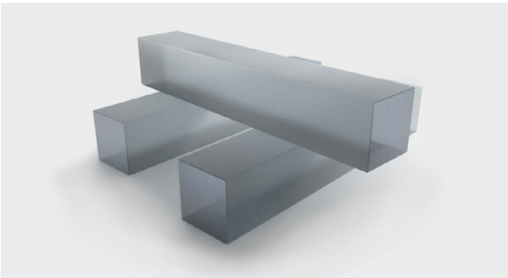
PHYSICAL AND OPTICAL PROPERTIES	
Chemical formula	$Ba(NO_3)_2$
Crystal structure	Cubic, $P2_13$
Lattice parameters	a = b = c = 8,11 Å
Density	3,25 g/cm^3
Mohs hardness	2,5-3
Transparency range	0,33 µm - 1,8 µm
Refractive index	1,555@1064 nm
Thermal conductivity	1,17 $Wm^{-1}K^{-1}$@||c
Thermal expansion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

Standard products

FACE DIMENSIONS	LENGTH	COATINGS	SKU	PRICE
5 x 5 mm	15 mm	AR/AR@500-700 nm	7269	630 €
	30 mm	AR/AR@500-700 nm	7270	760 €
	45 mm	AR/AR@500-700 nm	7271	900 €
8 x 8 mm	75 mm	AR/AR@500-700 nm	7272	1010 €

Minimum order quantity: 2 pieces.

KGW crystals



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

Main features

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

Application examples

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

Standard specifications

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

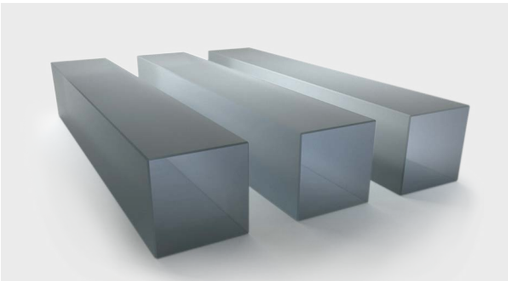
Properties

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

Standard products

FACE DIMENSIONS	LENGTH	COATINGS	SKU	PRICE
5 x 5 mm	15 mm	Uncoated	7259	390 €
		AR/AR@450-800 nm	7262	540 €
	30 mm	Uncoated	7260	490 €
		AR/AR@450-800 nm	7263	640 €
	45 mm	Uncoated	7261	680 €
		AR/AR@450-800 nm	7264	830 €

KYW crystals



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

Main features

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

Application examples

- Raman lasers
- Radiation frequency tuning

Standard specifications

KYW CRYSTALS	
Orientation	b-cut
Clear aperture	>90%
Face dimensions tolerance	+0/-0,1 mm
Length tolerance	±0,1 mm
Parallelism error	<20 arcsec
Perpendicularity error	<10 arcmin
Protective chamfers	<0,1 mm at 45°
Surface quality	10-5 S-D
Surface flatness	<λ/8@632,8 nm
Wavefront distortion	<λ/4@632,8 nm
Coatings	AR{R<0,7%}@500-650 nm
Laser induced damage threshold	>10 J/cm²@1064 nm, 10 ns
Mount	Unmounted

Properties

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

Standard products

FACE DIMENSIONS	LENGTH	COATINGS	SKU	PRICE
5 x 5 mm	15 mm	Uncoated	7273	390 €
		AR/AR@450-800 nm	7276	540 €
	30 mm	Uncoated	7274	490 €
		AR/AR@450-800 nm	7277	640 €
	45 mm	Uncoated	7275	680 €
		AR/AR@450-800 nm	7278	830 €