# Passive q-switch crystals

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

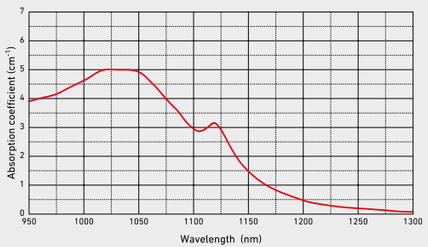
4Lasers develops and supplies different passive Q-switch crystal hosts and ion dopant combinations for research and industrial applications, therefore custom solutions are available upon request.

Cr:YAG crystals

V:YAG crystals

Co:Spinel crystals

# Cr:YAG crystals




$Cr^{4+}$:YAG crystals are ideal for passive Q-switch operation of Nd:YAG and other $Nd^{3+}$ or $Yb^{3+}$ doped laser crystals in the wavelength range of 900 nm to 1200 nm. Remarkable feature of $Cr^{4+}$:YAG is the high damage threshold of >10 J/cm²@1064 nm, 10 ns. Its absorption band extends from 900 nm to 1200 nm and peaks around 1060 nm with a very large absorption cross-section.

## Main features

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

## Application examples

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

## Standard specifications

| CR:YAG CRYSTALS | |
|---|---|
| Initial transmission $T_0$ | 5-99 %@1064 nm |
| Initial transmission $T_0$ tolerance | ±1% (for values larger than 80 %) |
| Clear aperture | >90% |
| Face dimensions tolerance | +0,0/-0,1 mm |
| Parallelism error | <10 arcsec |
| Perpendicularity error | <10 arcmin |
| Protective chamfers | <0,1 mm at 45° |
| Surface quality | 10-5 S-D |
| Surface flatness | <λ/8@632,8 nm |
| Wavefront distortion | <λ/4@632,8 |
| Coatings | AR(R<0,15%)@1064 nm on both sides |
| Laser induced damage threshold | >10 J/cm²@1064 nm, 10 ns |
| Mount | Unmounted |

## Properties

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

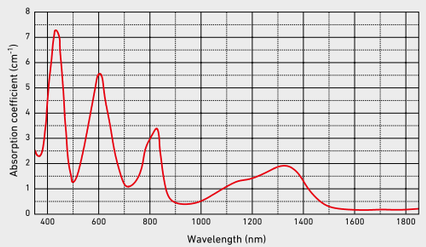
| | |
|---|---|
| Crystal structure | Cubic |
| Density | 4,56 g/cm³ |
| Thermal expansion coefficient | 6,14 × $10^{-6}$ $K^{-1}$ |
| Thermal conductivity | 11,2 $Wm^{-1}K^{-1}$ |
| Mohs hardness | 8,2 |
| Refractive index | 1,82@1064 nm |

Herewith:
$\sigma_{gsa}$ [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 | PRICE |
|---|---|---|---|---|
| ø3 mm | 20%@1064 nm | AR/AR@1064 nm | 7279 | 195 € |
| | 30%@1064 nm | AR/AR@1064 nm | 7280 | 195 € |
| | 40%@1064 nm | AR/AR@1064 nm | 7281 | 195 € |
| | 50%@1064 nm | AR/AR@1064 nm | 7282 | 195 € |
| | 60%@1064 nm | AR/AR@1064 nm | 7283 | 195 € |
| | 70%@1064 nm | AR/AR@1064 nm | 7284 | 195 € |
| | 80%@1064 nm | AR/AR@1064 nm | 7285 | 195 € |
| | 85%@1064 nm | AR/AR@1064 nm | 7286 | 195 € |
| | 90%@1064 nm | AR/AR@1064 nm | 7287 | 195 € |
| | 95%@1064 nm | AR/AR@1064 nm | 7288 | 195 € |
| | 98%@1064 nm | AR/AR@1064 nm | 7289 | 195 € |
| ø6 mm | 20%@1064 nm | AR/AR@1064 nm | 7301 | 225 € |
| | 30%@1064 nm | AR/AR@1064 nm | 7302 | 225 € |
| | 40%@1064 nm | AR/AR@1064 nm | 7303 | 225 € |
| | 50%@1064 nm | AR/AR@1064 nm | 7304 | 225 € |
| | 60%@1064 nm | AR/AR@1064 nm | 7305 | 225 € |
| | 70%@1064 nm | AR/AR@1064 nm | 7306 | 225 € |
| | 80%@1064 nm | AR/AR@1064 nm | 7307 | 225 € |
| | 85%@1064 nm | AR/AR@1064 nm | 7308 | 225 € |
| | 90%@1064 nm | AR/AR@1064 nm | 7309 | 225 € |
| | 95%@1064 nm | AR/AR@1064 nm | 7310 | 225 € |
| | 98%@1064 nm | AR/AR@1064 nm | 7311 | 225 € |
| 3 x 3 mm | 20%@1064 nm | AR/AR@1064 nm | 7290 | 195 € |
| | 30%@1064 nm | AR/AR@1064 nm | 7291 | 195 € |
| | 40%@1064 nm | AR/AR@1064 nm | 7292 | 195 € |
| | 50%@1064 nm | AR/AR@1064 nm | 7293 | 195 € |
| | 60%@1064 nm | AR/AR@1064 nm | 7294 | 195 € |
| | 70%@1064 nm | AR/AR@1064 nm | 7295 | 195 € |
| | 80%@1064 nm | AR/AR@1064 nm | 7296 | 195 € |
| | 85%@1064 nm | AR/AR@1064 nm | 7297 | 195 € |
| | 90%@1064 nm | AR/AR@1064 nm | 7298 | 195 € |
| | 95%@1064 nm | AR/AR@1064 nm | 7299 | 195 € |
| | 98%@1064 nm | AR/AR@1064 nm | 7300 | 195 € |

# V:YAG crystals




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

## Main features

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

## Application examples

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

## Standard specifications

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

## Properties

| SPECTROSCOPIC AND THERMO-MECHANICAL PROPERTIES | | | | | | |
|---|---|---|---|---|---|---|
| Material | $\sigma_{gsa}$ [1]@1,34 µm | $\sigma_{esa}$ [2]@1,34 µm | $\tau_{sa}$ [3] | Laser crystal | $\lambda_{laser}$ | $\sigma_{gsa}/\sigma_{em}$ [4] |
| $V^{3+}:Y_3Al_5O_{12}$ | $72 \times 10^{-19}$ cm² | $7,4 \times 10^{-19}$ cm² | 5-37 ns | Pr:YAP | 0,747 µm | 10 |
| | | | | $Ti:Al_2O_3$ | 0,78 µm | 25 |
| | | | | Cr:LiCAF | 0,78 µm | 80 |
| | | | | Nd:GGG | 0,93 µm | - |
| | | | | Nd:YLF | 1,05 µm | 15 |
| | | | | Nd:YAG | 1,06 µm | 8 |
| | | | | $Nd:YVO_4$ | 1,06 µm | 1,5 |
| | | | | Yb:KYW | 1,035 µm | 70 |
| | | | | Nd:YAP | 1,34 µm | 24 |
| | | | | $Nd:GdVO_4$ | 1,34 µm | 30 |
| | | | | Er:glass | 1,54 µm | 45 |

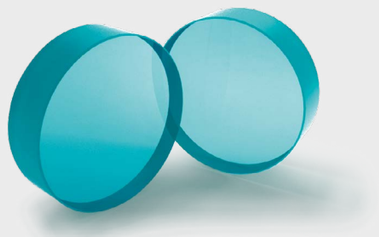
| | |
|---|---|
| Crystal structure | Cubic |
| Density | 4,56 g/cm³ |
| Thermal expansion coefficient | $6,14 \times 10^{-6}$ K⁻¹ |
| Thermal conductivity | 11,2 Wm⁻¹K⁻¹ |
| Mohs hardness | 8,2 |
| Refractive index | 1,82@1064 nm |

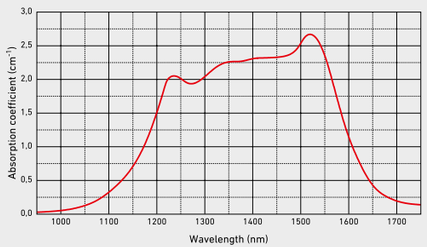
Herewith:
$\sigma_{gsa}$ [1] – ground-state absorption cross-section
$\sigma_{esa}$ [2] – excited-state absorption cross-section
$\tau_{sa}$ [3] – recovery time
$\sigma_{em}$ [4] – emission cross-section

## Standard products

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

# Co:Spinel crystals






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

## Main features

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

## Application examples

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

## Standard specifications

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

## Properties

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

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

Herewith:
$\sigma_{gsa}$ [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 | PRICE |
|---|---|---|---|---|
| 3 x 3 mm | 80%@1535 nm | AR/AR@1535 nm | 7331 | 340 € |
| | 85%@1535 nm | AR/AR@1535 nm | 7332 | 340 € |
| | 90%@1535 nm | AR/AR@1535 nm | 7333 | 340 € |
| | 92%@1535 nm | AR/AR@1535 nm | 7334 | 340 € |
| | 95%@1535 nm | AR/AR@1535 nm | 7335 | 340 € |
| | 97%@1535 nm | AR/AR@1535 nm | 7336 | 340 € |
| 5 x 5 mm | 80%@1535 nm | AR/AR@1535 nm | 7338 | 390 € |
| | 85%@1535 nm | AR/AR@1535 nm | 7339 | 390 € |
| | 90%@1535 nm | AR/AR@1535 nm | 7340 | 390 € |
| | 92%@1535 nm | AR/AR@1535 nm | 7341 | 390 € |
| | 95%@1535 nm | AR/AR@1535 nm | 7342 | 390 € |
| | 97%@1535 nm | AR/AR@1535 nm | 7343 | 390 € |