

Beta-Barium Borate (β -BBO) Crystal

Basic Product Information



β -BBO is a negative uniaxial crystal belonging to the trigonal crystal system. Featuring a non-centrosymmetric structure, it is widely recognized as one of the most outstanding second-order nonlinear optical crystals in the

- **Broad Transmission Range:** Covers 188 nm to 5200 nm, offering excellent transparency from the ultraviolet (UV) to the near-infrared (NIR) spectrum.
- **High Nonlinear Optical Coefficient:** The second-harmonic generation (SHG) coefficient is approximately 6 times that of KDP crystals, enabling extremely high frequency-doubling conversion efficiency.
- **High Laser Damage Threshold:** 750 MW/cm² @ 1064 nm, making it highly suitable for high-power laser systems.
- **Wide Phase-Matching Range:** Approximately 409.6 nm – 3500 nm, providing practical feasibility for a wide variety of nonlinear optical applications.

Key Applications

Thanks to its superior physical and optical properties, β -BBO crystals play a crucial role in cutting-edge fields such as laser technology, optical instrumentation, and scientific research:

- **Laser Harmonic Generation:** Widely used for second-, third-, fourth-, and even fifth-harmonic generation (frequency doubling, tripling, etc.), as well as sum/difference frequency mixing in Nd:YAG, Nd:YLF, Ti:Sapphire, and dye lasers.
- **Optical Parametric Amplification and Oscillation:** Excels in Optical Parametric Amplifiers (OPAs) and Oscillators (OPOs), generating widely tunable laser outputs across a broad wavelength range from UV to IR.
- **Advanced Laser R&D:** An ideal candidate for frontier technologies including all-solid-state tunable lasers, ultrafast (femtosecond) pulsed lasers, deep-ultraviolet (DUV) lasers, and quantum optics (e.g., quantum entanglement).
- **Electro-Optic Modulation & Q-Switching:** low-stress electro-optic switches based on large-aperture slab β -BBO crystals have been successfully developed. They are applied in high-energy, high-repetition-rate laser systems (such as hybrid-cavity Nd:YAG lasers) to achieve high-performance pulsed laser output.

Product Specifications

Dimensions	Customized
Angular Tolerance	$\Delta\theta < \pm 0.25^\circ$; $\Delta\phi < \pm 0.25^\circ$
Dimensional Tolerance	± 0.1 mm
Phase-Matching Type	Type I & Type II
Flatness	$< \lambda/10$ @ 632.8 nm
Wavefront Distortion	$< \lambda/8$ @ 632.8 nm
Surface Quality	10/5 (per MIL-O-13830A standard)
Parallelism	$< 20''$
Perpendicularity	$< 5''$
Clear Aperture	$> 90\%$
Damage Threshold	750MW/cm ² @1064nm
Coating	Customized (AR or HR coatings available)

Typical Application Cases

Multi-Harmonic Output of Nd:YAG Lasers

The fundamental wavelength of an Nd:YAG laser is 1064 nm. Using BBO crystals, highly efficient second harmonic (532 nm green), third harmonic (355 nm UV), fourth harmonic (266 nm DUV), and even fifth harmonic (213 nm) can be generated. For instance, fourth-harmonic generation of nanosecond pulses at 1064 nm using a BBO crystal can yield 532 nm picosecond laser output with a pulse width of 620 ps and adjustable energy up to 300 mJ. The beam quality is near-Gaussian, making it ideal for precision machining and scientific research.

Frequency Doubling and Supercontinuum Generation in Ti:Sapphire Femtosecond Systems

Near-infrared femtosecond pulses (~800 nm) from Ti:Sapphire lasers often require conversion to the visible or UV range for specific experimental needs. With its low group velocity dispersion and broad phase-matching bandwidth, BBO is the preferred material for efficient second-harmonic generation (400 nm) and third-harmonic generation (267 nm). It is also used to generate supercontinuum white light sources, providing broadband coherent light for spectroscopy and pump-probe experiments.

Core Gain Medium in OPO/OPA Systems

In OPO/OPA systems, a strong pump beam (e.g., 1064 nm or 532 nm) enters the BBO crystal, where nonlinear interactions generate two tunable beams: the signal and the idler. Due to its broad transmission range and excellent phase-matching characteristics, BBO enables wide tuning from the UV to the mid-infrared, finding extensive applications in molecular spectroscopy, environmental monitoring, and biological imaging.

Entangled Photon Sources in Quantum Optics

In cutting-edge quantum information science, BBO crystals are utilized in Spontaneous Parametric Down-Conversion (SPDC) to generate entangled photon pairs. When a pump beam (e.g., 405 nm) passes through the BBO crystal, it has a certain probability of splitting into two correlated photons (e.g., 810 nm) with linked energy and momentum. These two photons exist in an entangled state in terms of polarization, time, or space. This unique property makes BBO a core component for building quantum key distribution (QKD), quantum teleportation, and quantum computing prototypes

www.signoraoptics.cominfo@signoraoptics.com