Beta-barium Borate (BBO) is a nonlinear optical crystal used in a wide variety of phasematching applications. Its properties also make it an ideal candidate material for transverse field Pockels cells. Inrad Optics grows BBO crystals using a proprietary top seeded flux growth method. All crystal growth, orientation, fabrication, polishing, coating and testing of BBO crystal components takes place in our New Jersey facility, assuring you of complete traceability and satisfaction with every crystal we produce. Inrad Optics can fabricate and polish BBO crystals to almost any size and orientation.

### Features
- Large effective nonlinear coefficients
- Broad phasematching range from 410 to 2100 nm
- Wide optical transmission range from 200 to 2100 nm
- High laser damage threshold
- Low thermo-optic coefficient

### Advantages
- Second harmonic generation to generate wavelengths as short as 204.8 nm
- Shorter wavelengths can be generated by sum frequency mixing
- Fifth harmonic generation of Nd:YAG by mixing the fundamental and the fourth harmonic

### ordering Information
- **Sizes.** Crystal lengths range from 50μm for extremely short pulse widths to about 20 mm for nanosecond OPO/OPA use. Aperture sizes can be as large as 20 x 20 mm. The optimum length is largely determined by the angular acceptance of the crystal for phasematching.
- **Orientation.** Specify Type I or Type II and the phase match angle (θ). Crystals are oriented in a double crystal x-ray spectrometer and are typically accurate to within 1 arcminute.
- **Finishing.** Transmitted wavefront distortion is typically λ/10. Crystals can be wedged, typically 30 arcseconds in the less critical tuning direction or made parallel to <5 seconds. Surface finish is 10/5 or better. Alternatively, crystals can be made with a Brewster cut when used with high laser damage applications requiring low insertion losses.
- **Coatings.** BBO crystals are available with a thin, transparent protective dielectric coating that first and foremost protects the polished surfaces of this water-soluble crystal from fogging due to ambient moisture. The protective coating also:
  - Reduces reflection from the polished surface, improving transmission for all wavelengths.
  - Allows for fewer beam components, maximizing nonlinear conversion efficiencies.
  - Reduces temporal distortions when ultrafast light pulses are used.
### BBO Standard Orientations

<table>
<thead>
<tr>
<th>Designation</th>
<th>Angle $\theta$</th>
<th>Operation</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>“O”</td>
<td>68.5°</td>
<td>SHG</td>
<td>418-464 nm</td>
<td>209-232 nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(600-665 nm) + (300-331 nm)</td>
<td>200-220 nm</td>
</tr>
<tr>
<td>“T”</td>
<td>53.2°</td>
<td>SHG</td>
<td>454-560 nm</td>
<td>209-232 nm</td>
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<td></td>
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<td>(651-800 nm) + 325-400 nm</td>
<td>217-266 nm</td>
</tr>
<tr>
<td>“2”</td>
<td>37.4°</td>
<td>SHG</td>
<td>542-820 nm</td>
<td>271-410 nm</td>
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<td></td>
<td></td>
<td>(774-1165 nm) + (387-582 nm)</td>
<td>258-388 nm</td>
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<tr>
<td>“A”</td>
<td>78°</td>
<td>SHG</td>
<td>410-433 nm</td>
<td>205-216 nm</td>
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<td></td>
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<td></td>
<td>(594-620 nm) + (297-310 nm)</td>
<td>198-206 nm</td>
</tr>
<tr>
<td>“B”</td>
<td>55°</td>
<td>SHG</td>
<td>448-543 nm</td>
<td>224-271 nm</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(642-775 nm) + (321-358 nm)</td>
<td>214-258 nm</td>
</tr>
<tr>
<td>“C”</td>
<td>65°</td>
<td>SHG</td>
<td>423-480 nm</td>
<td>211-240 nm</td>
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<tr>
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<td>(608-687 nm) + (304-343 nm)</td>
<td>203-229 nm</td>
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<tr>
<td>“TSS”</td>
<td>28.7°</td>
<td>SHG</td>
<td>636-1000 nm</td>
<td>318-500 nm</td>
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<td>(906-2100 nm) + (453-1050 nm)</td>
<td>302-700 nm</td>
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<tr>
<td>“TST”</td>
<td>44°</td>
<td>SHG</td>
<td>496-675 nm</td>
<td>248-337 nm</td>
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<td>(710-960 nm) + (355-480 nm)</td>
<td>237-320 nm</td>
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<tr>
<td>“OPO1”</td>
<td>36.6°</td>
<td>SHG</td>
<td>549-844 nm</td>
<td>275-422 nm</td>
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<td></td>
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<td>(784-1200 nm) + (392-600 nm)</td>
<td>262-400 nm</td>
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<td>SFM 1064 nm + (510-567 nm)</td>
<td>345-370 nm</td>
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<tr>
<td>“OPO2”</td>
<td>57.5°</td>
<td>SHG</td>
<td>440-525 nm</td>
<td>220-262 nm</td>
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<td></td>
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<td>(632-750 nm) + (316-375 nm)</td>
<td>211-250 nm</td>
</tr>
<tr>
<td>“M1”</td>
<td>50.2°</td>
<td>SFM</td>
<td>1064 nm + (243-340 nm)</td>
<td>198-257 nm</td>
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<tr>
<td>“DGN”</td>
<td>31°</td>
<td>SFM</td>
<td>1064 nm + (380-980 nm)</td>
<td>280-510 nm</td>
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<tr>
<td>“IDL”</td>
<td>20°</td>
<td>SHG</td>
<td>1380-1460 nm</td>
<td>690-730 nm</td>
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<td>“OPO3”</td>
<td>30°</td>
<td>OPO</td>
<td>355 nm</td>
<td>410-2000 nm</td>
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<td>“SHG”</td>
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<td>SHG</td>
<td>1064 nm</td>
<td>532 nm</td>
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<td>THG</td>
<td>1064 nm + 532 nm</td>
<td>355 nm</td>
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<td>4HG</td>
<td>532 nm</td>
<td>266 nm</td>
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<tr>
<td>—</td>
<td>22°</td>
<td>SHG</td>
<td>1550 nm</td>
<td>775 nm</td>
</tr>
</tbody>
</table>

*BBO crystals are normally supplied with a single-layer MgF2 protective coating*

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### Orientation Types

**Type I**

\[ \lambda_1 < \lambda_2 \leq \lambda_3 \]

**Type II**

\[ \lambda_1 < \lambda_2 \leq \lambda_3 \]

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