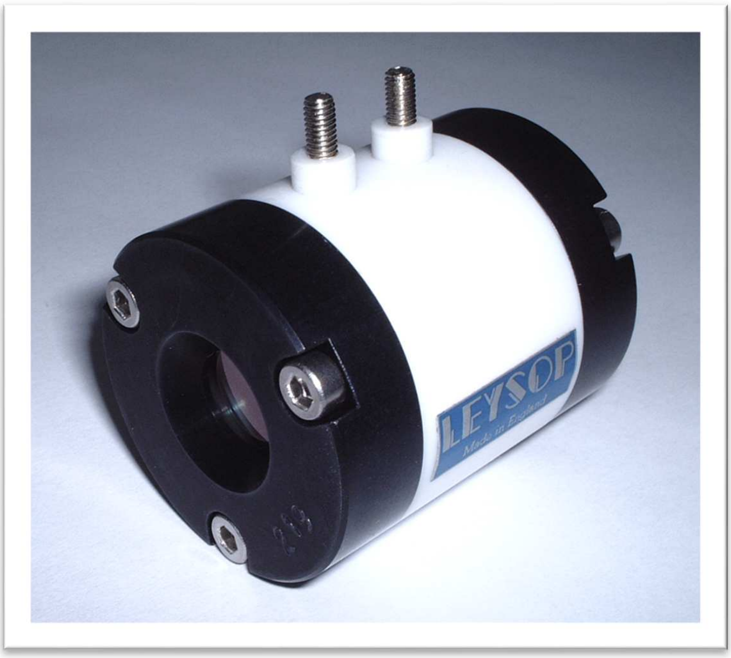
LEYSOP LTD

Manufacturers and suppliers of electro-optic components

BBO Pockels cell Q-switch System



- Low piezo-electric ringing
- Highest power handling
- Wide transmission range
- High extinction ratio
- AR coating options
- 35mm diameter package

Technically we should be discussing β-BBO to distinguish it from the α-BBO form which although chemically identical has a centre of symmetry in its crystal structure which robs it of any electro-optic effect (but it still makes an excellent polarizer)! For brevity though we shall just refer to BBO from now.

There are of course quite a few materials which do possess an electro-optic effect and selecting the optimum material for a given application is not always easy. It will depend on many factors, but when high power handling is important it is usually the case that BBO provides by far the best solution. It features good optical transparency from around 200nm to over 2µm and very importantly for intra-cavity laser operation, offers a high resistance to optical damage with power handling >3GW/cm^2 for 1ns pulses at 1064nm. Average power handling is also far higher than in other materials and it is possible to use BBO Pockels cells at average power levels of hundreds of watts and power densities of several kW/cm^2.

In addition to this excellent power handling, BBO Q-switches have very low levels of piezo-electric resonances. For Q-switching, lasers up to 50 or even up to 100kHz are practical, for pulse picking applications for which the electrical excitation pulse is very much shorter the limit has been demonstrated to be >4MHz (driver limited).

Comparisons with RTP are fairly obvious as they both lend themselves well to high repetition rate applications. The advantage of BBO is that the optical propagation is along the optical axis of the material (Z-direction) so there is no static birefringence and thermal stability is excellent. This, along with the high crystal homogeneity, provides a high extinction ratio which for single crystal devices is usually ~1,000:1 or even higher. In RTP the light propagation axis is either along the X or Y axes, both of which exhibit birefringence so some form of birefringence compensation is required. It is more difficult to achieve such high contrast therefore in the RTP Pockels cell.

Surely then there has to be a reason why BBO is not the preferred EO material for almost all applications? There is, and that is the operating voltage. The electro-optic coefficient of BBO is quite low and so for a given crystal dimension the half wave voltage will be much higher than for just about any comparable Pockels cell. For example, a 3x3mm cross section by 20mm long crystal has an effective half wave voltage at 1064nm of approximately 7kV. Even though it is a transverse field device so can be made more sensitive by making crystals long and thin, there are practical limits to the lengths of individual crystals which are related to the aperture. For up to 4x4mm cross section crystals, the maximum practical length in the Z-direction is 25mm. For crystals greater than 4mm aperture but up to 8 or 9mm, the maximum available length is 20mm and for larger apertures the length must fall even more. It is often the case then that the only practical method of bringing voltages down to acceptable levels (particularly with larger aperture crystals) is to use two crystals in series. This is not like the RTP cell, there is no birefringence compensation occurring, but it is just to apply the available voltage to two crystals in series and hence to double the effect produced.

Although we will make just about any practical BBO Pockels cell to suit your requirements, there are a number of standard sizes and combinations of crystals which we try to use. Usually the devices are mounted in a 35mm diameter package, the length of which is determined by the total length of BBO crystal(s) used. The exception to this is where a package with coaxial connectors is required, either for safety (use on an open bench) or for reasons of the drive scheme (e.g. a through connected driver). In such cases we would typically use our EM500 series packages. Whichever package style is used, it must be sealed with optical windows because BBO is mildly hygroscopic and cannot withstand operation in high levels of humidity without degradation over time of the optical faces.

The standard devices are designated as with most of our transverse field Pockels cells, by a part number which defines the material, the aperture, the crystal length, and any AR coating specifications. A 4mm aperture crystal of length 25mm with AR coatings for 1064nm then would be model BBO-4-25-AR1064. A cell with crystal length greater than 20 or 25mm (depending on aperture) will be a double crystal cell, e.g. BBO-5-40-AR800.

Product Specifications

Parameter	Value
Transmission (e.g. at 1064nm)	>98.5%
Apertures Available	2, 3, 4, 5, 6, 7, 8mm standard *
Half wave voltages at 1064nm	Approx. 7kV for 3x3x20mm crystal **
Contrast ratio	up to 30dB or more typically
Capacitance	From 5 to 10pF typically
Damage Threshold	>1GW/cm^2 at 1064nm (τ = 10ns)
Available Wavelengths:	220nm – 2,000nm ***

* Larger apertures are available but practical limitations of operating voltage provide some restrictions, for example, double crystal cells may be required.

** For other crystal dimensions the voltage will scale linearly with aperture and inversely with length.

*** Operation at 2µm will be restricted in maximum power because of the onset of optical absorption. Full power performance is available up to ~1.8µm.