

BBO Crystals



DESCRIPTION

β -BBO Crystal—a widely used nonlinear crystal for frequency conversion in the ultraviolet, visible and near-infrared. BBO Crystal is one of the most important nonlinear optical crystals, beta-barium borate (β -BaB₂O₄ β -BBO) combines many outstanding features such as its high nonlinear optical coefficients, low group-velocity dispersion, broad transparency range (189–3500 nm) and high damage threshold. This unique combination ensures β -BBO crystal a promising candidate for a wide range of nonlinear optical applications such as frequency converters and optical parametric oscillators. In the realm of quantum optics, β -BBO crystal can be used to generate entangled photon pairs and ten-photon entanglement.

BBO nonlinear crystal is a negative uniaxial crystal, which provides phase matching for various second-order interactions almost over its entire transparency range (from 185 nm to 3.3 μ m, as deduced from the transmittance measurements using crystal samples of several mm thickness), making it a widely used crystal for nonlinear frequency conversion in the ultraviolet, visible and near-infrared. In that regard, BBO crystal is the most important nonlinear crystal for near infrared optical parametric chirped pulse amplifiers, which currently deliver few optical cycle pulses with high average and ultrahigh peak powers.

FEATURES

- The range of transmission is from 190 nm to 3500nm
- Good physical properties
- Appropriate mechanical properties
- Effective SHG(Second-harmonic generation) coefficient is large
- Damage threshold of 100 ps pulse with 10 J/cm² at 1064 nm
- The range of phase matching is large from 409.6 nm to 3500nm

APPLICATIONS

- Material Processing
- Optical Communication
- Radar and Ranging
- Medical Applications



PARAMETER

Physical and Chemical Properties

Property	Value
SHG Phase Matchable Range	409.6 3500nm (Type I); 525 3500nm (TypeII)
NLO Coefficients	$d_{11} = 5.8 \times d_{36}(\text{KDP}); d_{31} = 0.05 \times d_{11}; d_{22} < 0.05 \times d_{11}$ $d_{\text{eff}}(\text{I}) = d_{31} \sin \theta + (d_{11} \cos 3\phi - d_{22} \sin 3\phi) \cos \theta$ $d_{\text{eff}}(\text{II}) = (d_{11} \sin 3\phi + d_{22} \cos 3\theta) \cos 2\theta$
Therm-Optic Coefficients	$d_{no}/dT = -9.3 \times 10^{-6}/^{\circ}\text{C}$ $d_{ne}/dT = -16.6 \times 10^{-6}/^{\circ}\text{C}$
Electro-Optic Coefficients	$g_{11} = 2.7 \text{ pm/V}, g_{22}, g_{31} < 0.1 g_{11}$
Half-Wave Voltage	48 KV (at 1064 nm)
Damage Threshold	
at 1.064 μm	5 GW/cm ² (10 ns); 10 GW/cm ² (1.3 ns)
at 0.532 μm	1 GW/cm ² (10 ns); 7 GW/cm ² (250 ps)

Other Parameters

Linear Thermal Expansion Coefficient		
T [K]	$\alpha_{\parallel c} \times 10^6 [\text{K}^{-1}], c$	$\alpha_{\perp c} \times 10^6 [\text{K}^{-1}], \perp c$
293	0.36	-2.54
Mean Value of Linear Thermal Expansion Coefficient		
T [K]	$\alpha_{\parallel c} \times 10^6 [\text{K}^{-1}], c$	$\alpha_{\perp c} \times 10^6 [\text{K}^{-1}], \perp c$
298-1173	36	4
Specific Heat Capacity at P =0.101325MPa		
T [K]	$c_p [\text{J/kgK}]$	
298	490/496	
Thermal Conductivity Coefficient		
K[W/mK] , c	K[W/mK] , $\perp c$	
0.8	0.08	
1.6	1.2	

Nonlinear Optical Properties

Property	Value
Chemical Formula	BaB ₂ O ₄
Crystal Structure	trigonal, 3m
Lattice Parameter	a=b=12.532Å, c=12.717Å, Z=6
Mass Density	3.85 g/cm ³
Moh Hardness	4
Melting Point	About 1095°C
Thermal Conductivity	1.2 W/m/K ($\perp c$); 1.6 W/m/K ($\parallel c$)
Thermal Expansion Coefficient	$\alpha_{\parallel c} \times 10^{-6}/\text{K}; \alpha_{\perp c} \times 10^{-6}/\text{K}$
Birefringence	negative uniaxial

Temperature Variation of Phase-matching Angle at T =293K

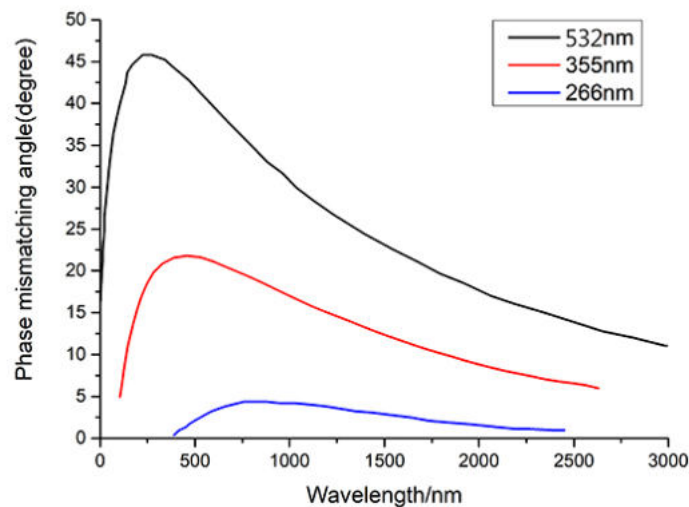
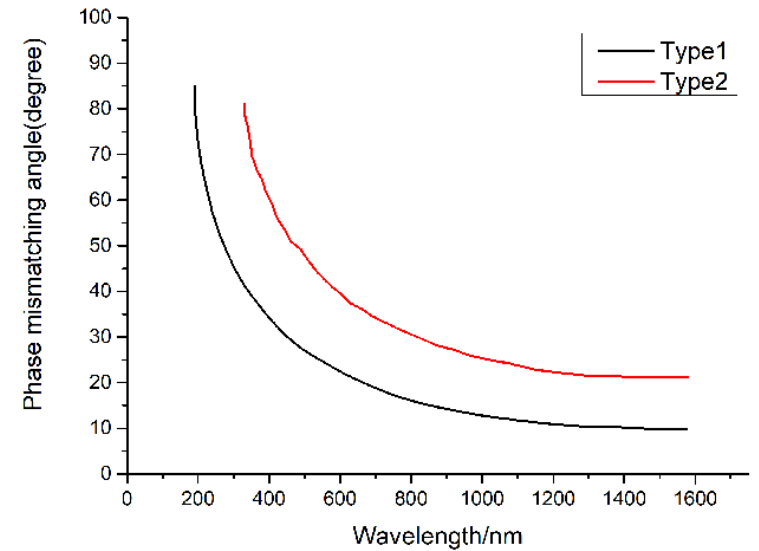
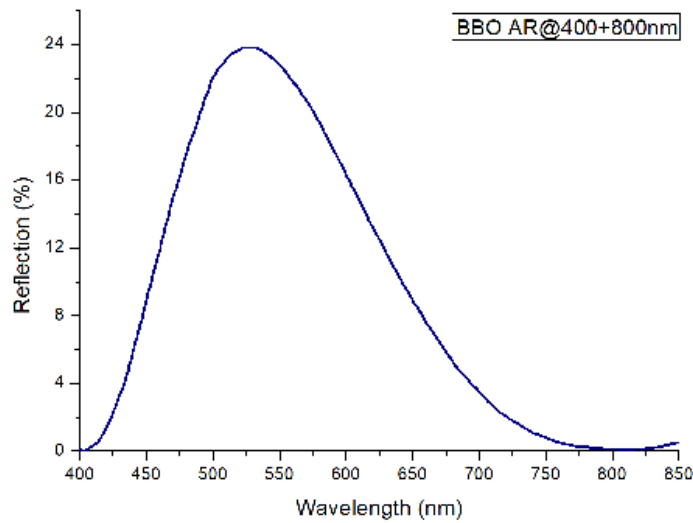
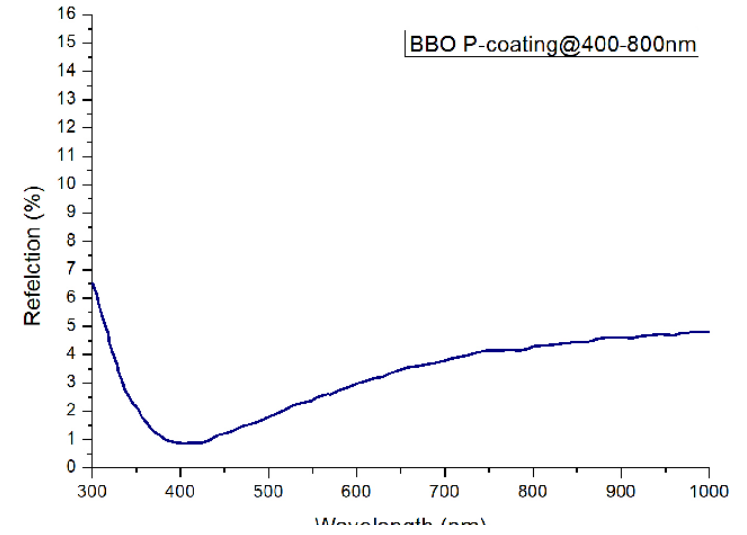
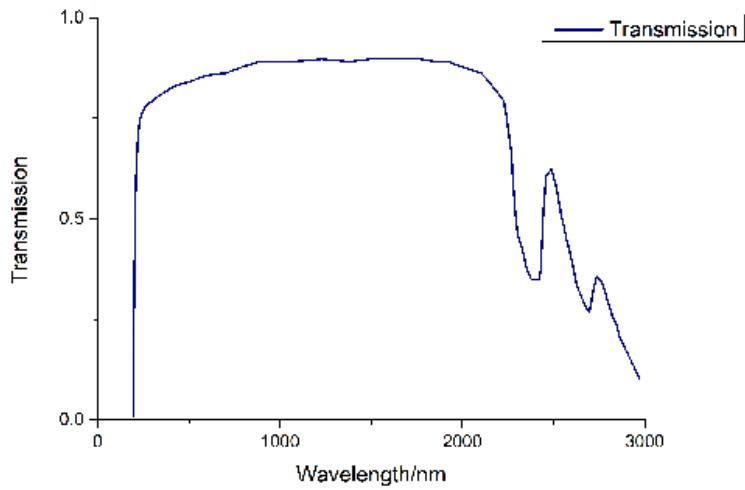
wavelengths [μm]	θ_{pm} [deg]	$d\theta_{\text{pm}}/dT$ [deg/K]
SHG, o+o \Rightarrow e		
0.5321 \Rightarrow 0.26605	47.3	0.0025
1.0642 \Rightarrow 0.5321	22.7	0.00057
SFG, o+o \Rightarrow e		
1.0642+0.5321 \Rightarrow 0.35473	31.1	0.00099
SHG, e+o \Rightarrow e		
1.0642 \Rightarrow 0.5321	32.4	0.0012
SFG, e+o \Rightarrow e		
1.0642+0.5321 \Rightarrow 0.35473	38.4	0.0015
SFG, o+e \Rightarrow e		
1.0642+0.5321 \Rightarrow 0.35473	58.4	0.00421

Nonlinear Refractive Index

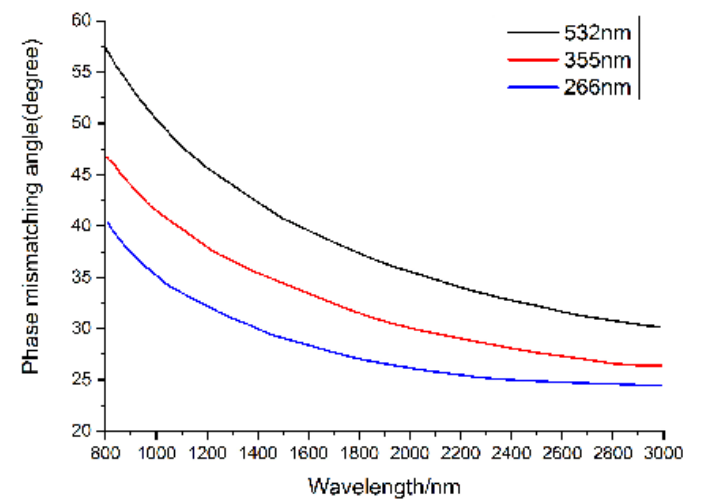
λ [μm]	$\gamma \times 10^{15} [\text{cm}^2/\text{W}]$	Note
0.2661	0.025 \pm 0.008	$ c$
0.3547	0.36 \pm 0.08	$ c$
0.5321	0.55 \pm 0.10	$ c$
0.78	0.40 \pm 0.05	[100] direction
	0.32 \pm 0.05	[010] direction
0.85	0.37 \pm 0.06	$\theta = 29.2^{\circ}, \phi = 0^{\circ}$
1.0642	0.29 \pm 0.05	$ c$



SPECTRA



SHG tuning curves of BBO



OPO tuning curves of BBO (TypeI (oee))with different pump light, namely 530 nm, 355 nm and 266 nm

OPO tuning curves of BBO (TypeII (eoe))with different pump light, namely 530 nm, 355 nm and 266 nm

