



## DESCRIPTION

$\text{ZnGeP}_2$  (Zinc germanium phosphide) crystal has many good properties and is an mid-IR nonlinear crystal. The nonlinear susceptibility of  $\text{ZnGeP}_2$  (ZGP) crystal is approximately 160 times large ( $d_{36} \sim 75 \text{ pm/V}$ ) as KDP,.ZGP shows good optical transparency over the 0.74–12 mm and relatively high laser damage threshold, and is therefore well suited for producing near infrared tunable laser. ZGP is a very hopeful material for mid-infrared devices such as SHG, SFG, OPO, and OPG/OPA.

## FEATURES

- Large Nonlinear coefficient
- The region of transmission is from 0.74  $\mu\text{m}$  to 12 $\mu\text{m}$
- High relative damage threshold
- High thermal conductivity
- The region of transparency is wide
- Phase matching over a broad spectral region

## APPLICATIONS

- OPA(optical parametric amplification)
- SHG(second-harmonic generation)
- OPO(optical parametric oscillators)

## PARAMETERS

### PHYSICAL AND CHEMICAL PROPERTIES

Property	Value
Chemical formula	$\text{ZnGeP}_2$
Crystal structure	Tetragonal,42m
Lattice parameters	$a=b=5.467\text{\AA}$ , $c=12.736\text{\AA}$
Mass Density	4.16 $\text{g/cm}^3$
Moh Hardness	5.5
Melting Point	About 1040°C
Thermal Conductivity	180 $\text{W/m/K}$
Thermal Expansion Coefficient	$\beta_{  }, 5 \times 10^{-6}/\text{K}$ ; $\beta_{\perp}, 7.8 \times 10^{-6}/\text{K}$
Birefringence	positive uniaxial



## NONLINEAR OPTICAL PROPERTIES

Property	Value
SHG Phase Matchable Range	3177~10357nm (Type I)
NLO coefficients	$d_{36}=75 \pm 8$ pm/V Type I $d_{eoo} = d_{36} \sin 2\theta \cos 2\varphi$ Type II $d_{oeo} = d_{eoo} = d_{36} \sin \theta \sin 2\varphi$
Damage Threshold	
at 1064nm	5 GW/cm <sup>2</sup> (10 ns); 10 GW/cm <sup>2</sup> (1.3 ns)
at 532nm	1 GW/cm <sup>2</sup> (10 ns); 7 GW/cm <sup>2</sup> (250 ps)

## EXPERIMENTAL VALUES OF PHASE-MATCHING ANGLE (T = 293K)

Interacting wavelengths[nm]	$\theta_{\text{exp}}$ [deg]
SHG, e+e → o	
3928 → 1964	57.8
4340 → 2170	55.8
4640 → 2320	47.5
4780 → 2390	49.2
5269 → 2648	46.8
9200 → 4600	63.8
9305 → 4653	64
9500 → 4750	66.8
9600 → 4800	65.8
10600 → 5300	80.1
SFG, e+e → o	
10668+4340 → 3085	54.3
10591+5295 → 3530	52.1
10591+3530 → 2648	48.4
9740+4204 → 2937	49.6
5295+3530 → 2118	51.7
SFG, o+e → o	
6740+5204 → 2937	76
6450+5391 → 2937	79.2
6250+5539 → 2937	84
6150+5620 → 2937	85.5
6290+5017 → 2791	76
6190+5080 → 2791	77.6
6060+5174 → 2791	80.5
5950+5257 → 2791	83.4
10591+1064 → 967	84

## EXPERIMENTAL VALUES OF INTERNAL ANGULAR BANDWIDTHS AT T = 293K

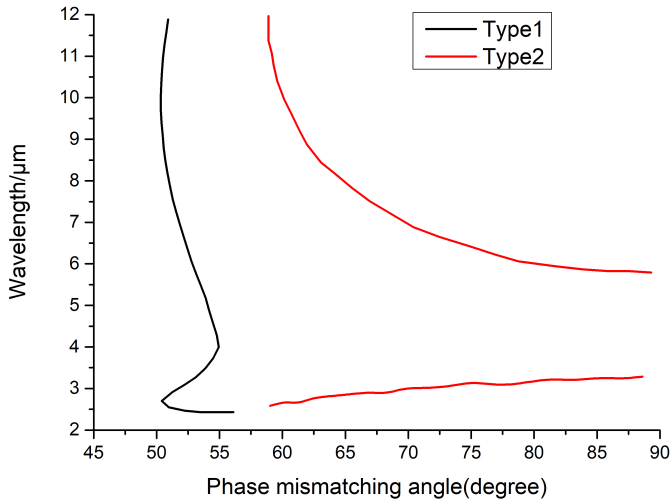
Interacting wavelengths[nm]	$\Delta\theta^{\text{int}}$ [deg]
SHG, e+e → o	
3800 → 1900	1.33
4340 → 2170	1.05
5300 → 2650	0.69
7800 → 3900	0.5
9300 → 4650	0.83
9550 → 4775	0.89
9600 → 4800	0.8
10200 → 5100	1.35
10300 → 51500	1.2
SFG, e+e → o	
10668+4340 → 3085	1.23
SFG, o+e → o	
10600+1064 → 967	0.55

## LINEAR OPTICAL PROPERTIES

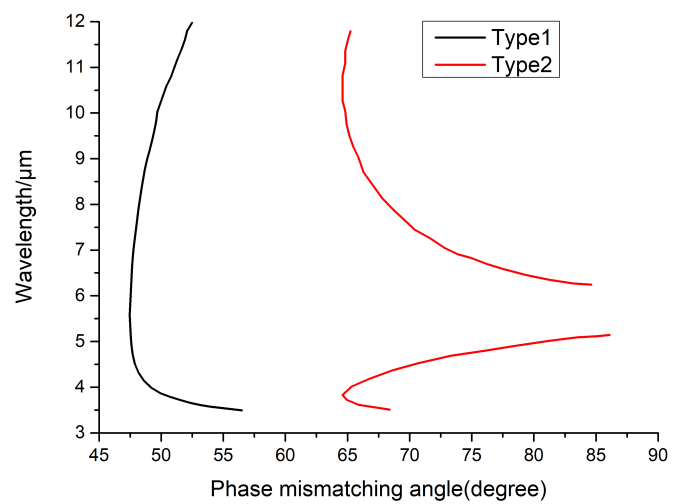
Property	Value
Transparency Range	0.74 – 12 $\mu\text{m}$
Absorption Coefficient	$\alpha < 0.05 \text{cm}^{-1}$ @ 2050-2100 nm
Refractive Indices	
@ 2.05 $\mu\text{m}$	$n_o = 3.1478, n_e = 3.1891$
@ 2.79 $\mu\text{m}$	$n_o = 3.1333, n_e = 3.1744$
@ 5.30 $\mu\text{m}$	$n_o = 3.1136, n_e = 3.1547$
@ 10.6 $\mu\text{m}$	$n_o = 3.0729, n_e = 3.1143$
Sellmeier Equations ( $\lambda$ in $\mu\text{m}$ )	$n_o^2(\lambda) = 4.64467 + 5.10087/(\lambda^2 - 0.13656) + 4.27777\lambda^2/(\lambda^2 - 1653.89)$ $n_e^2(\lambda) = 4.71539 + 5.26358/(\lambda^2 - 0.14386) + 2.37310\lambda^2/(\lambda^2 - 1000.82)$



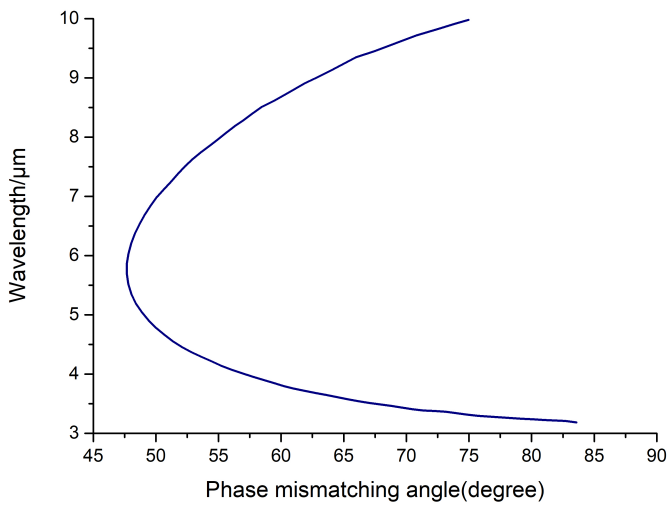
## SPECTRA



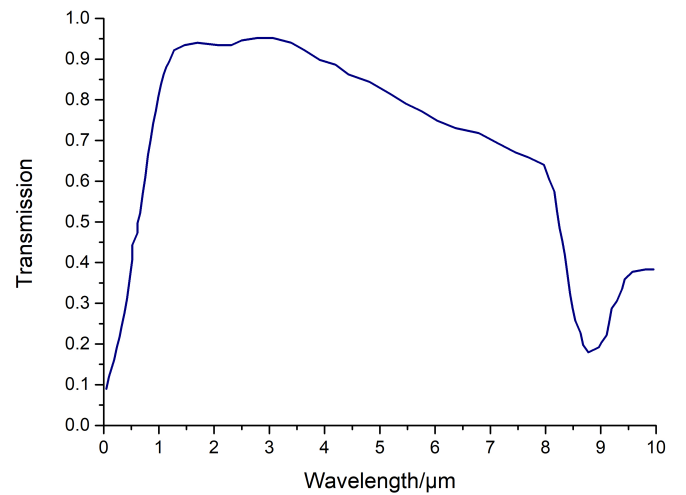
OPO tuning curves of ZGP with pump light of 2090 nm



OPO tuning curves of ZGP with pump light of 2800 nm



SHG curves of ZGP (Type1 (eoo))



ZGP Nonlinear Crystal Transmission