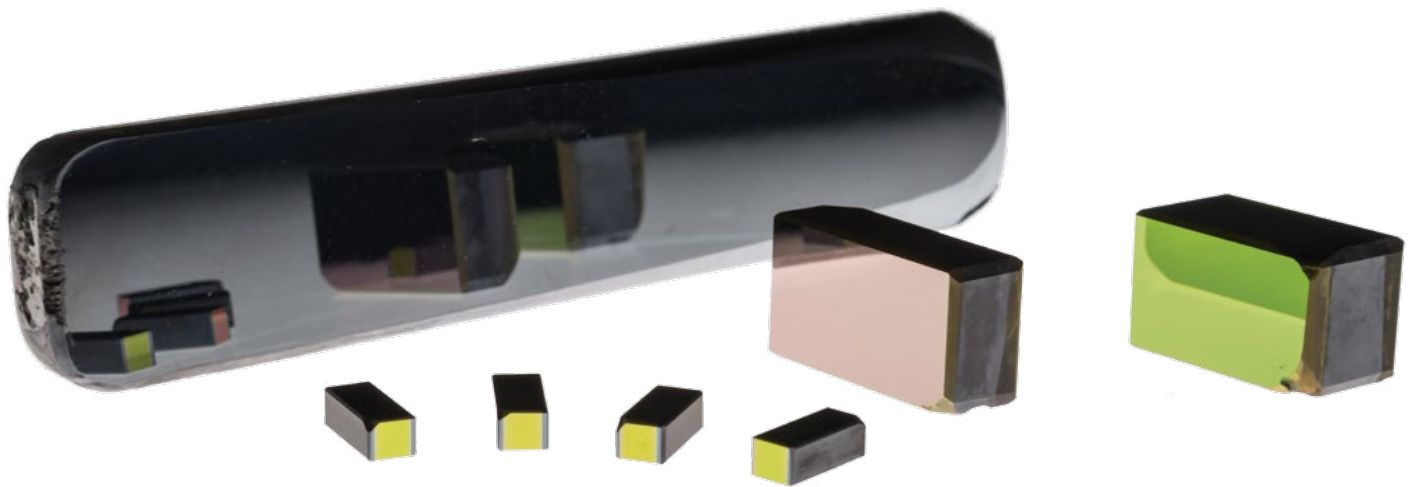


# Zinc germanium phosphide

Non-linear optical crystal



Zinc Germanium Phosphide ( $\text{ZnGeP}_2$ ) is the nonlinear optical crystal of choice in the 2–8  $\mu\text{m}$  spectral range due to its high thermal conductivity. Material improvements were made possible by advances in processing at BAE Systems. These advances have greatly reduced the defect-related absorption losses near the bandedge.

Zinc Germanium Phosphide can be used throughout its full transparency range in the mid-IR and has achieved high efficiencies and output power in the 3–5  $\mu\text{m}$  range.

## Features

- High non-linear coefficient:  $d_{14}=75 \text{ pm/V}$
- High thermal conductivity: 35 W/m-K
- Birefringence allows for most phase matching interactions over transparency range while producing minimal walkoff
- Thermal and mechanical robustness

## Benefits

- Enables efficient frequency conversion
- Allows high-power operation with manageable thermal lensing
- Converts 2 $\mu\text{m}$  light into other wavelengths over the 2–8  $\mu\text{m}$  region of highest transparency
- Allows for straightforward fabrication of device oriented crystals
- Available in large apertures for high energy applications

Note: Large-aperture material (>10 x 10 mm<sup>2</sup>) available upon request

## Crystallographic data

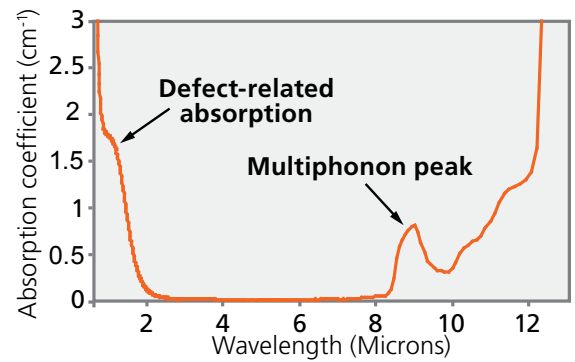
Chemical formula	ZnGeP <sub>2</sub>
Structure	Chalcopyrite
Crystal class and symmetry	Tetragonal (42m)
Lattice constants (Å)	a=5.465, c=10.707
Xray density (g/cm <sup>3</sup> )	4.153

## Thermomechanical properties

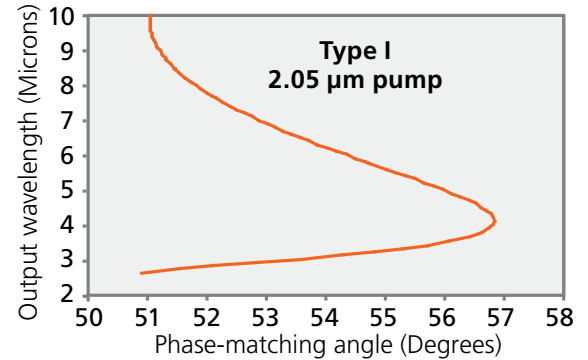
Hardness H <sub>v</sub> (kg/mm <sup>2</sup> )	980
Melting point (°C)	1027
Specific heat (J/g-K)	0.47
Thermal conductivity (W/m-K)	35
Thermal expansion coefficient (10 <sup>-6</sup> °C <sup>-1</sup> )	5.0 (  c), 7.8 (⊥c)

## Optical properties

Transparency range (μm) <sup>a</sup>	0.72 to 12.3	
Nonlinear coefficient, d <sub>14</sub> (pm/V) <sup>b</sup>	75	
Refractive index <sup>c</sup>	n <sub>o</sub>	
2.0 μm	3.148	3.190
4.0 μm	3.123	3.169
4.6 μm	3.119	3.156
9.2 μm	3.085	3.124
Sellmeier coefficients (n <sup>2</sup> = A + (Bλ <sup>-2</sup> ) / (λ <sup>2</sup> - C) + Dλ <sup>2</sup> )	n <sub>o</sub>	n <sub>e</sub>
A	8.0409	8.0929
B	1.68625	1.8649
C	0.40824	0.41468
D	1.28801	0.84052
E	611.05	452.05
Absorption coefficient, α (cm <sup>-1</sup> )	o pol.	e pol.
1.06 μm	<1.6	<1.8
2.05 μm	<0.07	<0.15
3-8 μm	<0.01	<0.01
9.2 μm	0.59	0.50
Laser-damage threshold (J/cm <sup>2</sup> )	>3.0	



Optical absorption



Type I phase-matching curve for 2.05 micron pump source

## Sample size and orientation

Standard cut is for Type I phase matching,  $\phi=0^\circ$  (Type II,  $\phi=45^\circ$  is also available)

Typical dimensions are 6mm x 6mm x 14 mm<sup>3</sup>  
Larger sizes up to 15 x 15 x 22mm<sup>3</sup> available)

Thin plates are available up to 25 x 25 mm<sup>2</sup>

Phase-matching angles

2.05-μm pumped degenerate OPO	56.9°
9.27-μm pumped SHG	61.6°

NOTES: <sup>a</sup> Range over which the absorption coefficient, α, is below 3 cm<sup>-1</sup>.

<sup>b</sup> The value 111 pm/V in early ZnGeP<sub>2</sub> literature is based on an obsolete value for d<sub>ij</sub> GaAs

<sup>c</sup> n<sub>o</sub> = ordinary polarized (E⊥c), n<sub>e</sub> = extra-ordinary polarized (E||c)

# State-of-the-art crystal growth and processing

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Cleared for open publication on 02/17

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CS-16-H85-02