

# Barium Gallium Selenide

Long wave nonlinear optical crystal

Barium Gallium Selenide ( $\text{BaGa}_4\text{Se}_7$ , BGSe) is a new nonlinear optical crystal for frequency conversion in the 1–16  $\mu\text{m}$  spectral range with the ability to pump at wavelengths as short as 1  $\mu\text{m}$ .

## Features

Nonlinear coefficient, no clear consensus:  
 $d_{\text{eff}} \sim 5\text{-}27 \text{ pm/V}$

Wide transparency range from 454 nm to 17  $\mu\text{m}$   
allows flexible application

Flat tuning curve when pumping at 2  $\mu\text{m}$  allows for  
broad range of infrared generation 4-12  $\mu\text{m}$

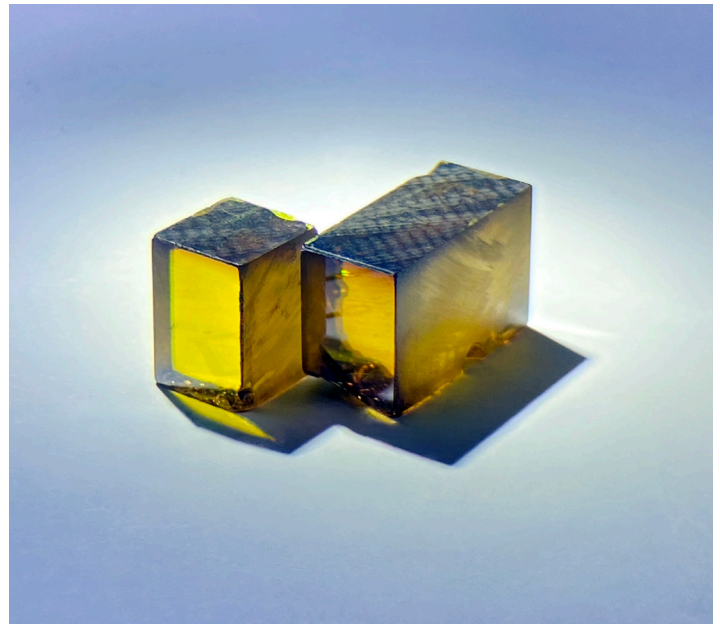
For large beam diameters, crystals available in large  
apertures ( $> 10 \times 10 \text{ mm}^2$ ) with no inclusions

## Benefits

Higher damage threshold than crystals used for similar  
applications ( $\text{AgGaSe}_2$ )

Ability to convert wavelengths as short as 1.064  $\mu\text{m}$   
without 2-photon absorption enhances efficiency

No evidence of long-term photobleaching or  
photodarkening, allowing for longer lifetime devices



# A novel solution for long wave infrared lasing

## Crystallographic data

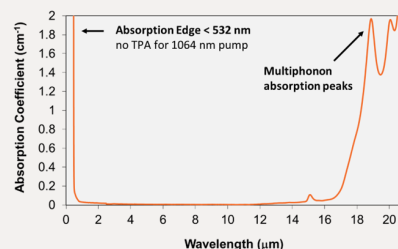
Chemical formula	BaGa <sub>4</sub> Se <sub>7</sub>
Structure	Defect Chalcopyrite
Crystal class and symmetry	Monoclinic (Pc)
Lattice constants in dielectric frame (Å)	x=6.5, y=12.56 z=7.6
X-ray density (g/cm <sub>3</sub> )	4.99

## Thermo-mechanical properties

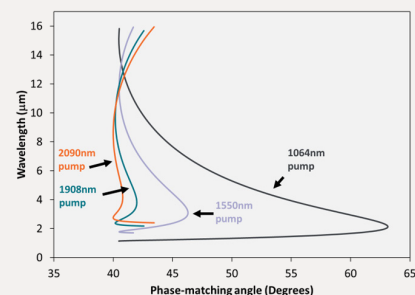
Hardness H <sub>v</sub> (kg/mm <sub>2</sub> )	336
Melting point (°C)	1050
Thermal conductivity (W/m-K)	a=0.74, b=0.64, c=0.56
Thermal expansion coefficient (10 <sup>-6</sup> °C <sup>-1</sup> )	a=9.24, b=10.76, c=11.70

## Optical properties

Transparency range (μm)	0.454 – 16		
Nonlinear coefficient, d (pm/V)	~5 – 27		
Refractive index	n <sub>x</sub>	n <sub>y</sub>	n <sub>z</sub>
1.0 μm	2.49379	2.51005	2.56730
2.0 μm	2.44552	2.46210	2.51383
4.0 μm	2.43109	2.44793	2.49847
10.0 μm	2.40526	2.42327	2.47324
Sellmeier coefficients (n <sub>z</sub> <sup>2</sup> =A1+A3/(λ <sup>2</sup> -A2)+A5/(λ <sup>2</sup> -A4))	n <sub>x</sub>	n <sub>y</sub>	n <sub>z</sub>
A1	6.72431	6.86603	7.16709
A2	0.04248	0.04259	0.06973
A3	0.26375	0.26816	0.32681
A4	756.87	781.78	790.16
A5	608.63	682.97	731.86
Absorption coefficient, α (cm <sup>-1</sup> )			
1.06 μm	0.02		
2.05 μm	0.01		
2.35 μm	0.01		
AR-coated Laser-damage threshold (J/cm <sub>2</sub> )	>1.0		



Optical absorption of BaGa<sub>4</sub>Se<sub>7</sub> single crystal.



Type I XZ phase-matching curves for three different pump sources

## Sample size and orientation

Standard cut is for type I XZ phase matching,  $\phi=0^\circ$   
 Standard dimensions are 5mm x 5mm and between 1 - 10 mm in length (other sizes available)

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