



# Benchmark® Polarizers GS12000 Series

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## *User Manual*





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# 1. Introduction

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Thank you for purchasing a Specac Product.

Polarizers are commonly used to polarize radiation from unpolarized sources, attenuated radiation from polarized sources, or act as polarizing beamsplitters. Specac offers a range of holographic wire polarizers laid onto a transmitting substrate material for use in the 1 - 35 $\mu\text{m}$  (10000 $\text{cm}^{-1}$  - 285 $\text{cm}^{-1}$ ) spectral range.

The process involves exposing a photo-resist coating on a suitable material substrate to an interferometrically-generated fringe pattern from a monochromatic UV source. The regular sinusoidal profile of the developed photo-resist is subsequently metal coated at an oblique angle to create an array of fine parallel lines at a set period. This technique lends itself well to the generation of extremely uniform sub-micron grid wire spacing's (an option of 2500 or 4000 lines per mm), which have a significantly reduced level of light scattering in comparison to traditional ruled wire grid polarizers. As the wire grid is formed on the photo-resist itself, the technique is also well suited to fabricating polarizers on substrates that do not otherwise lend themselves to the ruling process.

The Benchmark® Polarizers that are provided as part of the GS12000 Series range of polarizers available from Specac consist of a specific substrate material that has a polarized grid photo-etched onto one surface of the circular substrate material. Each polarizer substrate option has a polarizing grid of 4000 lines per mm onto a substrate of 29mm diameter and 2mm thickness.

The part numbers and choice of substrate materials available for the Benchmark® GS12000 Series polarizers are:

P/N GS12000 for KRS-5 – spectral transmission range 2 - 35 $\mu\text{m}$ .  
P/N GS12700 for Germanium – spectral transmission range 8 - 12 $\mu\text{m}$ .  
P/N GS12800 for CaF<sub>2</sub> – spectral transmission range 1 - 10 $\mu\text{m}$ .  
P/N GS12900 for BaF<sub>2</sub> – spectral transmission range 1 – 12.5 $\mu\text{m}$ .  
P/N GS12950 for ZnSe – spectral transmission range 1 - 15 $\mu\text{m}$ .

## User Manual

Specifically, for the GS12000 Series range of polarizers, the substrate material with a polarizer grid is supplied permanently mounted in a stainless steel “spring clip” ring mount.

The fixed outside diameter (O.D.) of the polarizer spring clip ring mount is 34.9mm and the clear aperture (C.A.) produced from the spring clip ring mount for the polarizer substrate is 25mm diameter. The overall thickness of the polarizer fitted with the ring mount is 7.9mm.

A metal tab piece on the spring clip ring mount is used to secure any of the GS12000 Series polarizers within the polarizer rotator 3” x 2” slide mount P/N GS12500, should different angles of polarized light (from 0° through to 90°) be required for spectral study and measurement. Instructions of how to fit and use a GS12000 Series polarizer in the polarizer rotator 3” x 2” slide mount P/N GS12500, are found within the rotator mounts own user manual.

Utilizing this style of spring clip ring mount, the GS12000 Series polarizers can also be installed directly into the aperture ports of any optical unit associated with the range of Specac Benchmark® baseplate mounted accessories. Such accessories include the Golden Gate™, Silver Gate™ and Gateway™ ATR systems. Instructions for fitting are found within the accessories own relevant user instruction manual and within this instruction manual.

This user instruction manual instructs on how to unpack and handle carefully the GS12000 Series polarizer supplied and informs how the grid pattern of the polarizer (4000 parallel lines per mm) is aligned in relation to the spring clip ring mount.

## 2. Safety Considerations

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When handling a polarizer correctly as advised, there are inherently minimal safety concerns to follow involved with their use.

Despite the general safety precaution to avoid touching any of the substrate materials and photo-etched polarizer grid where at all possible, depending upon **which** specific substrate material type for the Benchmark®/GS12000 Series polarizer that has been supplied and is to be used, there are certain safety precautions to observe associated with the substrate material.

Related to the specific polarizer substrate material type you have received or are using for the GS12000 Series polarizer, please refer to the relevant substrate material safety and handling information in Section 7 of this instruction manual.

### 3. Unpacking and Checklist

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The GS12000 Series polarizer can be supplied on its own or together with its dedicated rotator 3" x 2" slide mount P/N GS12500, if both these items have been ordered as a Benchmark® Polarizer Kit via P/N's GS12501, GS12502, GS12503, GS12504 or GS12505.

If the items have been ordered as a Kit they are supplied in a plastic carry case. If the items have been ordered separately, they will be supplied in their own individual packing.

On receipt please check that the following items have been supplied.

- A GS12000 Series polarizer of your choice in its own container. (If ordered as P/N GS12000, GS12700, GS12800, GS12900 or GS12950).
- A GS12000 Series polarizer of your choice and a rotator 3" x 2" slide mount P/N GS12500 in a plastic carry case. (If both items ordered as a Benchmark® Polarizer Kit).

#### Caution!



*When removing the items from their packing be especially careful with the GS12000 Series polarizer. The polarizer grid is very fragile and you **must** avoid contact with the polarizer substrate surface, otherwise the polarizer grid could be irreparably damaged. It is advisable to store the GS12000 Series polarizer in its original packing container when not being used.*



## 4. Instructions for Use

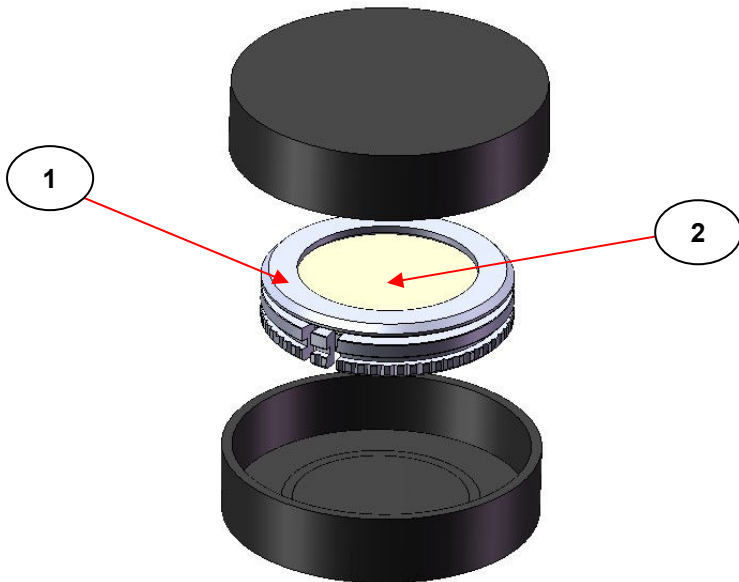
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All of the GS12000 Series polarizers are supplied with a stainless steel spring clip ring mount (1).

**Note:** *On no account is the polarizer substrate (2) to be removed from the spring clip ring mount (1).*

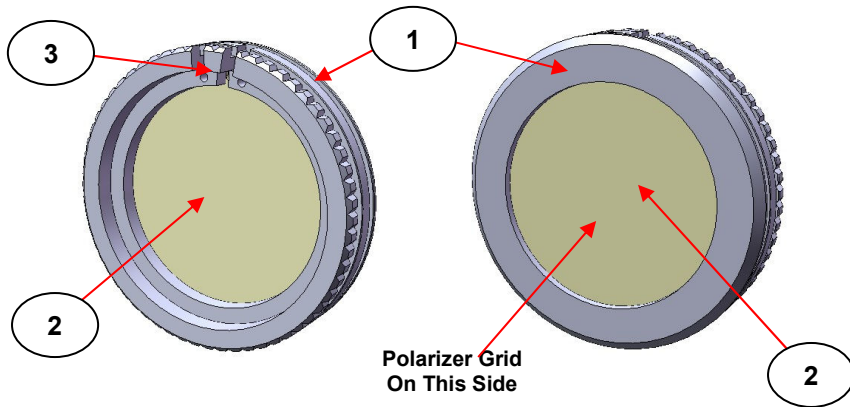
### Polarizer Grid on GS12000 Series Polarizers

As mentioned in Section 2, when removing the GS12000 Series polarizer from its packing, be very careful in its handling. The polarizer components (1) and (2) are held between two plastic lens cap covers with plastic tape wrapped around the circumference to seal the cap covers together. Carefully peel the tape away to gain access to the polarizer assembly (1) and (2). (See Fig 1.)



**Fig 1. GS12000 Series Polarizer as Supplied in Packing Covers**

The polarizer grid is deposited onto one surface of the substrate (2) material. This surface is **on the same side as the smooth ring support face** of the spring clip ring mount (1). The knurled face side with the spring clip ring is the “plain” surface of the substrate (no polarizing grid has been deposited). (See Fig 2.)

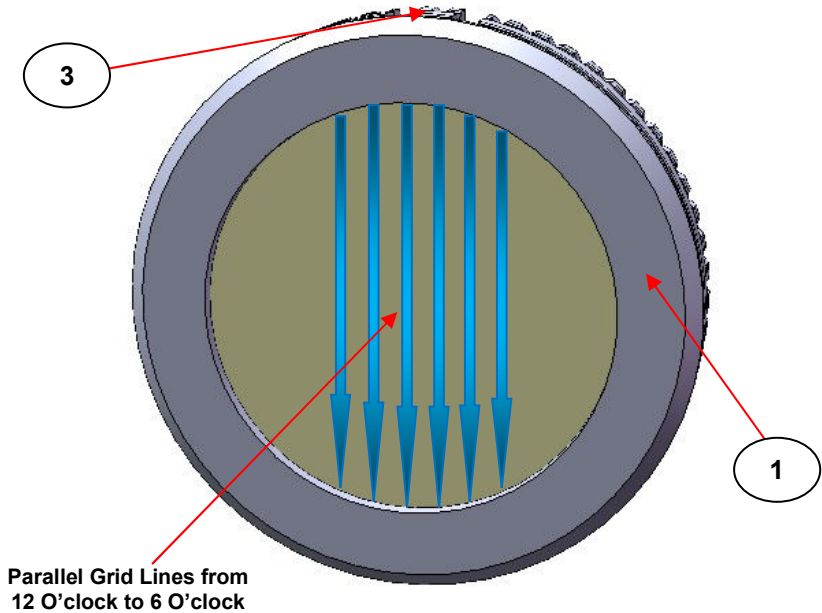


**Fig 2. Knurled and Smooth Surface Sides of Spring Clip Ring Mount for GS12000 Series Polarizers**

The GS12000 Series polarizers have a break in the spring clip ring mount (1) where a metal tab piece (3) is located. (See Figs 2 and 3.)

**Note:** *On the knurled face side of the GS12000 Series polarizer (no polarized grid deposit), the polarizers unique serial number identification has been engraved into the ring mount (1) near to the metal tab (3). It is advisable to keep a note of the serial number for your records.*

To determine the polarizer grid line pattern (4000 lines per mm) that has been deposited onto the substrate, if the metal tab (3) is positioned at a 12 O'clock position, the grid lines of the polarizer run parallel to the diameter of the substrate (2) that passes through the metal tab (3) to a 6 O'clock position on the spring clip ring mount (1).



**Fig 3. Polarizer Grid Line Orientation of Parallel Lines on the Substrate Surface of the GS12000 Polarizer**

## **Fitting a Benchmark®/GS12000 Series Polarizer**

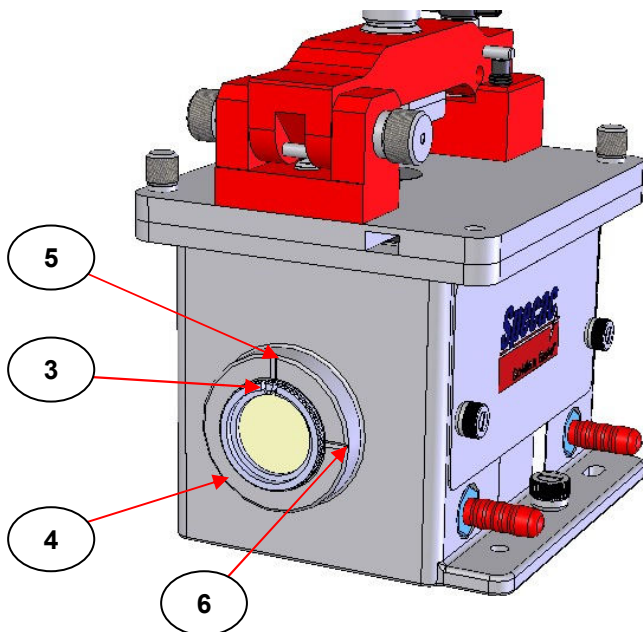
### **Fitting in the Polarizer Rotator 3" x 2" Slide Mount P/N GS12500**

The GS12000 Series polarizers have been specifically designed for mounting via the outer spring clip ring mount (1) into a dedicated polarizer rotator 3" x 2" slide mount P/N GS12500. Instructions of how to fit and use a GS12000 Series polarizer in the rotator 3" x 2" slide mount P/N GS12500 are to be found in this rotator mounts own user instruction manual.

### Fitting to the Optical Unit of a Specac FTIR Accessory

There are a variety of Specac Accessories that are installed into an infrared spectrometer system sample compartment by use of a Benchmark® style of baseplate. The “optical unit” part of the Accessory, which affixes to the Benchmark® baseplate, as standard has inlet and outlet aperture ports (4) for the passage of an infrared light beam for the accessory itself. These aperture ports (4) have been designed to accommodate a GS12000 Series polarizer, should studies of polarized light interaction against a specific sample type that can be studied with use of the Accessory be necessary.

Taking a Heated Golden Gate™ single reflection diamond ATR Accessory as an example for an optical unit, a GS12000 Series polarizer can be fitted into the aperture ports (4) as shown in Fig 4.



**Fig 4. Aperture Port of the Optical Unit of the Golden Gate™ Single Reflection Diamond ATR Accessory**

**Note:** *For the actual installation of a polarizer into a beam path of a source of light to sample and then to a detector, it does not matter if the polarizer is positioned before light has interacted with a sample (between the source and sample) or after interaction (between the sample and detector). The result of discriminating and measurement for a specific plane of polarized light from an angular setting of the polarizing grid deposited on the substrate material, when a polarizer is introduced into the beam passage sequence, is the same. With respect to the aperture ports (4) on an optical unit, either one can be used for installation of a GS12000 Series polarizer.*

From **Fig 4**, the GS12000 Series Polarizer is positioned within the aperture port (4) with the knurled surface side of the spring clip ring mount (1) facing outwards such that the metal tab (3) is seen. In this way the polarized grid deposited on the surface side of the substrate material (2) is facing inwards to the optical unit and helps to minimize any risk of accidental touching of this surface from finger print marks, when installing the polarizer.

**Note:** *It is advisable to wear gloves when handling any polarizer to avoid getting fingermarks on the polarizer substrate material (2) and to prevent any damage to the polarizer grid.*

To mount the GS12000 Series polarizer firmly into the aperture port (4), the metal tab (3) on the spring clip ring mount (1) may need to be bent slightly outwards, away from the centre of the polarizer. This movement will very slightly alter the overall circumference of the retaining spring clip ring for a tighter fit into the circular recess of the aperture port (4). Introduce the smooth face of the spring clip ring mount (1) towards the aperture port (4) and very carefully push the polarizer - BY THE RING MOUNT PART ONLY – into the aperture port (4) until it engages and is a nice tight fit. If it is a loose fit, adjust the tension by bending the metal tab (3) accordingly. If doing so, be careful not to touch the substrate material surface.

As shown in **Fig 4**, the metal tab (**3**) is aligned with the top notch (**5**) in the aperture port (**4**) at a 12 O'clock position. When installed in this position the lines of parallelism of the polarizer grid are running from the 12 O'clock to the 6 O'clock position on the aperture port (**4**). The lines of parallelism can be designated as positioned at an angle of  $0^\circ$  (zero degrees) and by convention in this orientation of the polarizer, light that is S (perpendicular) polarized is transmitted through the polarizer.

There is second notch (**6**) at the 3 O'clock position on the aperture port (**4**) and if the polarizer is similarly installed but such that the metal tab (**3**) aligns with the notch (**6**), then the lines of parallelism of the polarizer grid would be running from the 3 O'clock to the 9 O'clock position on the aperture port (**4**). The lines of parallelism can be designated as positioned at an angle of  $90^\circ$  (ninety degrees) compared to the  $0^\circ$  positioning and by convention in this orientation of the polarizer, light that is P (parallel) polarized is transmitted through the polarizer.

To change from a  $0^\circ$  angle orientation of the grid to the  $90^\circ$  angle orientation, the polarizer will need to be removed very carefully from the aperture port (**4**) and repositioned with alignment of the metal tab (**3**) to the corresponding notch (**5**) or (**6**). It may be possible to gauge by eye if the metal tab (**3**) is midway between the notches, such that an angle of circa  $45^\circ$  may be obtained for the polarizing grid, if this is a necessary requirement.

## General Cautions and Care of the Polarizer

The GS12000 Series polarizer grid consists essentially of very fine aluminium lines being deposited on a substrate material and they can very easily be damaged due to incorrect handling of the polarizer.

Should the polarizer grid be affected in any way by finger marks, dust or dirt, it is very likely that the performance of the polarizer will be

seriously impaired, and in certain cases the damage that has been sustained is irreparable. A new polarizer will be required.

Hence, some general rules to follow to care for your polarizer are:

- Do not touch, rub or abrade the polarizing grid or substrate surface.
- Do not wash the polarizing grid with organic solvents.
- Any dust that may be present on either surface of the substrate material should be gently blown clear using an air or nitrogen line.
- Always store the polarizer in its original packing container when not being used. If a Benchmark® Polarizer Kit was supplied, the GS12000 Series polarizer may be kept fitted into the rotator 3" x 2" slide mount P/N GS12500 and the whole assembly of parts can be stored in the supplied plastic carry case.

## *5. Legend – Bubble Part Number Identification*

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- (1) Spring clip ring mount of GS12000 Series polarizers.
- (2) Polarizer substrate material.
- (3) Metal tab on spring clip ring mount.
- (4) Aperture port on optical unit of FTIR Accessory.
- (5) Location notch at “12 O’clock” position on aperture port.
- (6) Location notch at “3 O’clock” position on aperture port.

## *6. Part Numbers for Benchmark®/GS12000 Series Polarizers*

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### **Polarizers**

- GS12000 KRS-5 substrate Benchmark® Polarizer.
- GS12700 Germanium substrate Benchmark® Polarizer.
- GS12800 CaF<sub>2</sub> substrate Benchmark® Polarizer.
- GS12900 BaF<sub>2</sub> substrate Benchmark® Polarizer.
- GS12950 ZnSe substrate Benchmark® Polarizer.

### **Polarizer Rotator 3” x 2” Slide Mount and Kits**

- GS12500 Benchmark® polarizer rotator 3” x 2” slide mount.
- GS12501 KRS-5 Benchmark® Polarizer Kit.
- GS12502 Germanium Benchmark® Polarizer Kit.
- GS12503 CaF<sub>2</sub> Benchmark® Polarizer Kit.
- GS12504 BaF<sub>2</sub> Benchmark® Polarizer Kit.
- GS12505 ZnSe Benchmark® Polarizer Kit.



## 7. Substrate Material Safety Information

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### KRS-5 Substrate Material – P/N GS12000

#### General

Synonyms: Mixture of Thallium Bromide and Thallium Iodide (typically 58% Iodide content).

Very toxic red coloured soft crystalline powder when fused together as a solid can be used as a transmission window material or as a crystal material for attenuated total reflectance (ATR) FTIR spectroscopy.

Slightly soluble in water, soluble in bases, but not soluble in acids. Not hygroscopic. Organic solvents have no effect.

Soft window material and easily deformed.

Molecular formula:  $TlBr_{0.4}I_{0.6}$

#### Physical Data

Appearance: Red, soft crystals, granular powder or red coloured window material

Melting point: 414°C

Solubility in water: 36g/100g at 0°C.

Hardness: 40 Kg/mm<sup>2</sup>.

Refractive Index: 2.38 (at 2000cm<sup>-1</sup> - wavenumbers).

Spectroscopic transmission range: 17,000 to 250 cm<sup>-1</sup> (wavenumbers).

#### Stability

Stable.

#### Toxicology



Very toxic if small amounts are inhaled or swallowed. May be fatal if swallowed. May be absorbed through the skin. Irritant.

#### Personal Protection

Always wear safety spectacles and gloves when handling the powder or window material.

Allow for good ventilation. If material is machined, polished or ground, precautions must be taken against inhalation of dust.

#### Storage

Keep powder or windows stored in a cool, dry container, with appropriate safety labelling.

## Germanium Substrate Material – P/N GS12700

### General

Hard and very brittle material, but can be shaped, cut and polished to form spectral transmission window or crystal for ATR spectroscopy.

Because of its high Refractive Index value suffers from large reflection losses but these can be improved with antireflection optical coatings

Is temperature sensitive and loses transmission when heated. (Is optically opaque to IR transmission at 190°C temperature.)

Insoluble in water and alcohols. Soluble in hot sulphuric acid and aqua regia.

Element symbol: Ge

Chemical Abstracts Service (CAS) No: 7440-56-4.

### Physical Data

Appearance: Greyish/black, opaque, elemental, metallic solid. Has no odour.

Melting point: 737°C.

Boiling point: 2830°C.

Vapour pressure:  $2.66 \times 10^{-56}$  mm Hg at 25°C.

Specific gravity: 5.323 g cm<sup>-3</sup>.

Solubility in water: Insoluble

Hardness: 780 Kg/mm<sup>2</sup>.

Refractive Index: 4.01 (at 2000cm<sup>-1</sup> - wavenumbers).

Spectroscopic transmission range: 5,500 to 500 cm<sup>-1</sup> (wavenumbers).

### Stability

Stable.

### Toxicology



Harmful if ingested in large amounts, if inhaled, or if in repeated contact with the skin.

### Personal Protection

Always wear safety spectacles and gloves when handling the window or crystal material.

Allow for adequate ventilation.

### Storage

Keep windows or crystal stored in a cool, dry container.

## CaF<sub>2</sub> Substrate Material – P/N GS12800

### General

Known as Calcium Fluoride, Calcium Difluoride, Fluorspar or Irtran 3. When powder is fused together, is used as a transmission window material. Insoluble in water, resists most acids and alkalis. Is soluble in ammonium salts. Its high mechanical strength makes it particularly useful for high pressure work. Brittle material sensitive to mechanical and thermal shock. Does not fog. Molecular formula: CaF<sub>2</sub>. Chemical Abstracts Service (CAS) No: 7789-75-5.

### Physical Data

Appearance: Odourless, white or colourless crystalline solid.  
Melting point: 1360°C.  
Boiling point: 2500°C.  
Solubility in water: 0.0017g/100g at 0°C.  
Hardness: 158 Kg/mm<sup>2</sup>.  
Refractive Index: 1.40 (at 2000cm<sup>-1</sup> - wavenumbers).  
Spectroscopic transmission range: 77,000 \* to 900 cm<sup>-1</sup> (wavenumbers).

### Stability

Stable.  
Incompatible with acids.

### Toxicology



Harmful if ingested in large amounts, if inhaled, or if in repeated contact with the skin.

### Personal Protection

Always wear safety spectacles and gloves when handling the powder or window material.  
Allow for adequate ventilation.

### Storage

Keep powder or windows stored in a cool, dry container.

(\* UV Grade material required for this range limit.)

## **BaF<sub>2</sub> Substrate Material – P/N GS12900**

### **General**

Synonyms: Barium Difluoride.

When powder is fused together, is used as a transmission window material.

Very slightly soluble in water, soluble in acids and ammonium chloride. Good resistance to fluorine and fluorides. Does not fog.

Its high mechanical strength makes it particularly useful for high pressure work.

Brittle material - very sensitive to mechanical and thermal shock.

Molecular formula: BaF<sub>2</sub>.

Chemical Abstracts Service (CAS) No: 7787-32-8.

### **Physical Data**

Appearance: Odourless, white or colourless crystalline solid.

Melting point: 1280°C.

Boiling point: 2137°C.

Solubility in water: 0.17g/100g at 0°C.

Hardness: 82 Kg/mm<sup>2</sup>.

Refractive Index: 1.45 (at 2000cm<sup>-1</sup> - wavenumbers).

Spectroscopic transmission range: 66,666 \* to 800 cm<sup>-1</sup> (wavenumbers).

### **Stability**

Stable.

Incompatible with acids.

### **Toxicology**



Harmful if ingested in large amounts, if inhaled, or if in repeated contact with the skin.

### **Personal Protection**

Always wear safety spectacles and gloves when handling the powder or window material.

Allow for adequate ventilation.

### **Storage**

Keep powder or windows stored in a cool, dry container.

(\* UV Grade material required for this range limit.)

## ZnSe Substrate Material – P/N GS12950

### General

Toxic and hard yellow coloured crystalline powder when fused together as a solid can be used as a transmission window material or as a crystal material for attenuated total reflectance (ATR) FTIR spectroscopy.

Insoluble in water, but attacked by strong acids and bases. (pH range 4 to 11 tolerant). Organic solvents have no effect.

Fairly brittle as a window material and sensitive to thermal and mechanical shock.

Molecular formula: ZnSe

Chemical Abstracts Service (CAS) No: 1315-09-9.

### Physical Data

Appearance: Yellow crystals, granular powder or amber coloured window material

Melting point: 1515°C at 1.8 atmospheres. (26.5psi)

Solubility in water: 0g/100g at 0°C.

Hardness: 120 Kg/mm<sup>2</sup>.

Refractive Index: 2.43 (at 2000cm<sup>-1</sup> - wavenumbers).

Spectroscopic transmission range: 20,000 to 500 cm<sup>-1</sup> (wavenumbers).

### Stability

Stable.

Reacts with acids to give highly toxic hydrogen selenide. May be air and moisture sensitive. Incompatible with strong acids, strong bases and strong oxidising agents.

### Toxicology



Toxic if small amounts are inhaled or swallowed. In stomach toxic hydrogen selenide (H<sub>2</sub>Se) is liberated. Skin and eye irritant. Danger of cumulative effects from frequent handling without protection.

### Personal Protection

Always wear safety spectacles and gloves when handling the powder or window material.

Allow for good ventilation.

### Storage

Keep powder or windows stored in a cool, dry container, with appropriate safety labelling.



# Worldwide Distribution

## **France**

Eurolabo - Paris.  
Tel.01 42 08 01 28  
Fax 01 42 08 13 65  
email: [contact@eurolabo.fr](mailto:contact@eurolabo.fr)

## **Germany**

L.O.T. - Oriel GmbH & Co,  
KG - Darmstadt  
Tel: 06151 88060  
Fax: 06151 880689  
email:[info@LOT-Oriel.de](mailto:info@LOT-Oriel.de)  
Website: [www.LOT-Oriel.com/de](http://www.LOT-Oriel.com/de)

## **Japan**

Systems Engineering Inc. -Tokyo  
Tel: 03 3946 4993  
Fax: 03 3946 4983  
email:[systems-eng@systems-eng.co.jp](mailto:systems-eng@systems-eng.co.jp)  
Website: [www.systems-eng.co.jp](http://www.systems-eng.co.jp)

## **Spain**

Teknokroma S.Coop C. Ltda  
Barcelona  
Tel: 93 674 8800  
Fax: 93 675 2405  
email: [comercial@teknokroma.es](mailto:comercial@teknokroma.es)

## **Switzerland**

Portmann InstrumentsAG  
Biel-Benken  
Tel: 061 726 6555  
Fax: 061 726 6550  
email: [info@portmann-instruments.ch](mailto:info@portmann-instruments.ch)  
Website:[www.portmann-instruments.ch](http://www.portmann-instruments.ch)

## **USA**

SPECAC INC.  
414 Commerce Drive  
Suite 175,  
Fort Washington,  
PA 19034, USA  
Tel: 215 793 4044  
Fax: 215 793 4011

## **United Kingdom**

Specac Ltd. - London  
River House, 97 Cray Avenue,  
Orpington  
Kent BR5 4HE  
Tel: +44 (0) 1689 873134  
Fax: +44 (0) 1689 878527  
Registered No. 1008689 England

# Brilliant Spectroscopy™

*[www.specac.com](http://www.specac.com)*

**SPECAC INC.**

414 Commerce Drive  
Suite 175,  
Fort Washington,  
PA 19034, USA  
Tel: 215 793 4044  
Fax: 215 793 4011

**SPECAC LTD.**

River House, 97 Cray Avenue,  
Orpington  
Kent BR5 4HE  
Tel: +44 (0) 1689 873134  
Fax: +44 (0) 1689 878527  
Registered No. 1008689 England