Standard Infrared Polarizers
GS57010 Series

User Manual

2I-57010-4

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CONTENTS - USER MANUAL

1. Introduction

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 - 35µm (10000cm^{-1} - 285cm^{-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 Standard Infrared Polarizers that are provided as the GS57010 Series range of polarizers available from Specac consist of a particular substrate material that has a polarized grid photo-etched onto one of the surfaces of the circular substrate material. Each polarizer substrate option has a polarizing grid of 4000 lines per mm onto a substrate material of varying diameters and thickness.

The substrate materials offered are, KRS-5, Germanium, CaF_2, BaF_2 and ZnSe and a substrate material with a photo-etched polarizer grid can be supplied against the dimensions for a particular GS57010 Series polarizer as seen in the "Table of GS57010 Series Polarizer Dimensions".

Note: *A 71mm Clear Aperture (C.A.) size ring mounted GS57010 Series polarizer cannot be supplied in KRS-5 substrate material.*

Table of GS57010 Series Polarizer Dimensions

Substrate Material	Substrate Size (dia. x thickness)	Ring Mount Size (dia x thickness)	Clear Aperture
ALL	25mm x 2mm	NONE	25mm
ALL	29mm x 2mm	41mm x 6.7mm	25mm
ALL	42mm x 4mm	55mm x 8.7mm	38mm
ALL	54mm x 4mm	70mm x 8.7mm	50mm
ALL (not KRS-5)	75mm x 5mm	90mm x 9.7mm	71mm

As seen from the table, options of an UNMOUNTED substrate material polarizer can be supplied with dimensions of 25mm diameter and 2mm thickness for the specific substrate material. Because there is no supporting ring mount for this size of substrate, the C.A. of the polarizer is the same as the substrate outside diameter (O.D.).

The GS57010 Series polarizers are offered in three particular classifications – **Standard**, High Extinction Ratio (**HER**) and Image Quality (**IQ**) Infrared polarizers.

For **Standard** Infrared polarizers, these are offered with a polarizer grid photo-etched onto **any** of the different substrate materials as listed from the full choice of support ring mount size. Manufactured at 4000 lines per mm these polarizers ensure enhanced performance at shorter wavelengths for precision applications.

For **HER** Infrared polarizers, these are offered in the same way as the **Standard** Infrared polarizer for substrates and support ring mount size options, but they are manufactured at 4000 lines per mm with an enhanced coating process that ensures a higher degree of polarization extinction without jeopardizing transmission throughput.

For **IQ** Infrared polarizers, these are offered in the same way as the **Standard** Infrared polarizer from the choice of support ring mount size options, but only as Germanium and ZnSe substrate materials. They are manufactured at 4000 lines per mm with particular anti-reflection coatings and a high specification of optical flatness and parallelism, which make these polarizers very well suited for imaging applications.

The substrate material chosen allows for a particular transmission range of light to be observed:-

For KRS-5 substrate material, transmission range 2 - 35µm.
For Germanium substrate material, transmission range 8 - 15µm.
For CaF_2 substrate material, transmission range 1 - 10µm.
For BaF_2 substrate material, transmission range 1 – 12.5µm.
For ZnSe substrate material, transmission range 1 - 15µm.

Specifically and generally for the GS57010 Series range of Standard, HER and IQ Infrared polarizers, the substrate material with a photo-etched polarizer grid is supplied permanently mounted in a black coloured anodized aluminium ring mount. The (O.D.), thickness and C.A. dimensions of the polarizer ring mount are different for the varying sizes of substrate material used. (See Table of GS57010 Series Polarizer Dimensions.) The supporting ring mount of the polarizer substrate material has three fixing holes that pass through the circumference in an equilateral triangle configuration allowing for the whole GS57010 Series polarizer assembly to be mounted independently using these three fixing holes if necessary.

However, the GS57010 Series Standard, HER and IQ Infrared polarizers can be specifically mounted by use of the GS57340 Series of rotator mounts under the P/N's GS57340, GS57350, GS57360 and GS57370. A specific instruction manual for these rotator mounts is supplied with them and should be used in conjunction with this user instruction manual for the GS57010 Series polarizers. A specific polarizer and mount combination can be supplied as a Standard Infrared Polarizer Kit based on the part number associated with the particular **Series size of rotator mount.**

This user manual will instruct how to use the GS57010 Series Standard, HER and IQ Infrared polarizers and will also inform how the grid pattern of the polarizer is aligned in relation to the outer mounting ring.

2. Safety Considerations

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** particular substrate material type for the GS57010 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 particular polarizer substrate material type you have received or are using for the GS57010 Series polarizer, please refer to the relevant substrate material safety and handling information in Section 7 of this instruction manual.

3. Unpacking and Checklist

The GS57010 Series polarizer can be supplied alone or together with its dedicated GS57340 Series rotator mount if both these items have been ordered as the Standard Infrared Polarizer Kit part number.

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 GS57010 Series polarizer of your choice in its own container. (If ordered as a GS57010 Series part number).
- A GS57010 Series polarizer of your choice and a dedicated rotator mount GS57340 Series in a plastic carry case. (If both items ordered as a Standard Infrared Polarizer Kit).

Caution!

*When removing the items from their packing be especially careful with the GS57010 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 GS57010 Series polarizer in its original packing container when not being used.*

4. Instructions for Use

All of the GS57010 Series polarizers (except the 25mm O.D. x 2mm thick substrate only options) are supplied with a black coloured, anodized aluminium ring mount (**1**).

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

Polarizer Grid on GS57010 Series Polarizers

As mentioned in Section 2, when removing the GS57010 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 polarizer assembly (**1**) and (**2**).

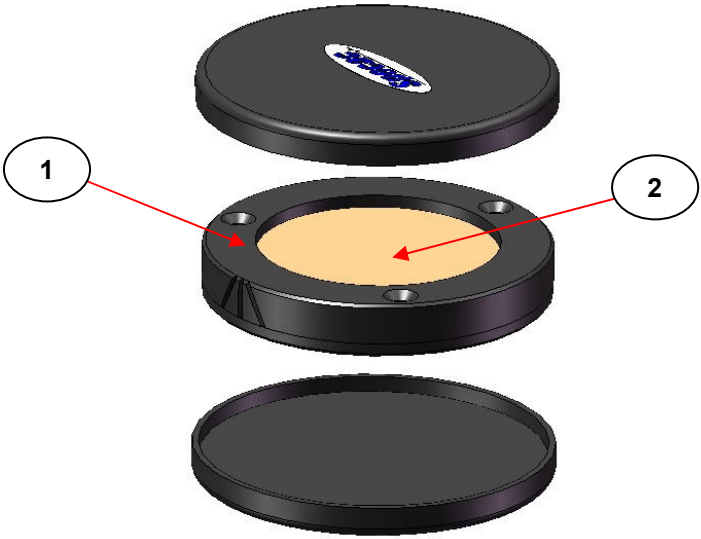


Fig 1. GS57010 Series Polarizer as Supplied in Packing Covers

The polarizer grid is deposited onto one surface of the substrate (**2**) material. On the circumference edge of the anodized aluminium ring mount (**1**) there is a 'V' notch mark (**3**) and the direction point of the 'V' denotes which side of the substrate (**2**) the polarizing grid has been deposited. (See **Fig 2.**) In addition, the surface of the ring mount that carries the labeling of the polarizer for the substrate material type and whether it is a Standard, HER or IQ polarizer, is on the same side of the substrate (**2**) as the polarized grid. (See label types at **Fig 4.**)

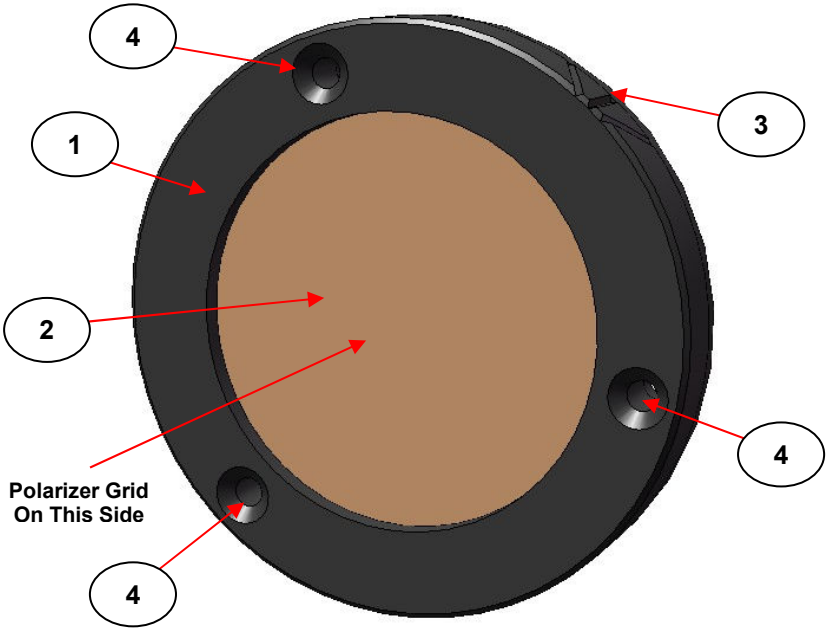


Fig 2. Polarizer Grid Surface Side of GS57010 Series Polarizers

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.*

The centre of the 'V' notch also acts to determine the lines of polarization laid down as the polarizing grid. (See **Fig 3.**)

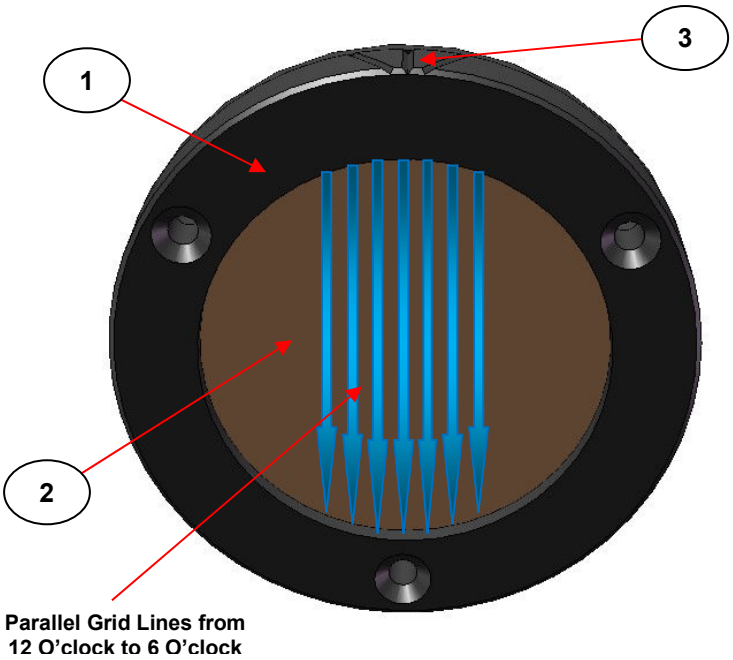


Fig 3. Polarizer Grid Line Orientation of Parallel Lines on the Substrate Surface of the GS57010 Polarizer

To determine the polarizer grid line pattern (4000 lines per mm) that has been deposited onto the substrate (**2**), if the 'V' notch mark (**3**) is positioned at a 12 O'clock position, the grid lines of the polarizer run parallel to the diameter of the substrate that passes through the 'V' notch mark (**3**) to a 6 O'clock position on the aluminium ring mount (**1**). For this orientation of the polarizer grid, the lines of parallelism can be considered to be at an angle of 0° (zero degrees) and by convention in this orientation of the polarizer, light that is S (perpendicular) polarized is transmitted through the polarizer.

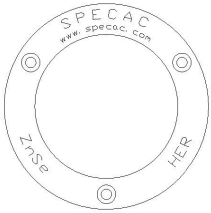
If the GS57010 Series polarizer grid is orientated such that the 'V' notch mark (**3**) is at a 9 O'clock position, the grid lines of the polarizer run parallel to the diameter of the substrate that passes through the 'V'

notch mark (**3**) to a 3 O'clock position on the aluminium ring mount (**1**). For this orientation of the polarizer grid, the lines of parallelism can be considered to be at an angle of 90° (ninety degrees) compared to the 0° positioning and by convention in this orientation of the polarizer, light that is P (parallel) polarized is transmitted through the polarizer.

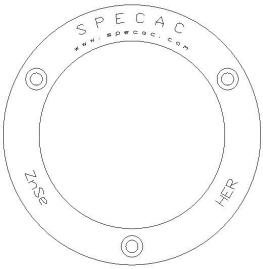
Labeling of the GS57010 Series Polarizer

In respect of the surface side of the polarizer for the substrate material (**2**) that has the deposited polarizer grid, the aluminium ring mount (**1**) surface has also been labeled accordingly to denote if it is a **Standard**, **HER** or **IQ** type of GS57010 Series polarizer. Fig 4. shows the four different sizes of aluminium ring mount (**1**) that correspond to the different sizes of substrate materials (**2**) available to provide a different size of C.A.

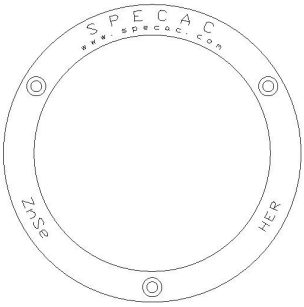
25mm C.A.



38mm C.A.



50mm C.A.



71mm C.A.

Fig 4. Labeling of the GS57010 Series Polarizer

Any of the polarizer types will be marked with **SPECAC** and the website address. This label will be found in the segment of the ring mount (**1**) surface between the two of the three fixing holes (**4**) that has the 'V' notch mark (**3**) at the centre of the circumference for the segment.

For **Standard** type polarizers the substrate material (**2**) is labeled as shown for the example of ZnSe in each of the polarizer ring sizes as shown in **Fig 4**. In relation to the **SPECAC** label. For **HER** type polarizers this label will also be printed in the segment of the ring mount as shown in relation to both the **SPECAC** and substrate material labels. For **IQ** type polarizers these will be labeled similarly as shown for an **HER** type polarizer but can be discriminated from the **HER** type alone by referring to the serial number of the polarizer that is engraved onto the opposite surface (non-labeled side) of the aluminium ring mount (**1**).

Note: ***Any*** *type of GS57010 Series polarizer supplied will have been individually identified for a unique serial number that can be found on the non-labeled side of the aluminium ring mount (**1**). It is advisable to keep a note of the serial number for your records to determine if it is a **Standard**, **HER** or **IQ** type GS57010 Series polarizer.*

Fitting a GS57010 Series Polarizer

Fitting Using the Polarizer Mounts Own Fixing Holes

For **any** type of GS57010 Series polarizer, the supporting aluminium ring mount (**1**) of the polarizer substrate material (**2**) has three fixing holes (**4**) that pass through the circumference in an equilateral triangle configuration. (See **Fig 2**.) The whole GS57010 Series polarizer assembly can be mounted independently using screws or bolts through these three fixing holes (**4**) if necessary.

The fixing holes (**4**) on the 25mm C.A. and 38mm C.A. ring mount (**1**) sizes have an internal diameter (I.D.) of 2.8mm and for the 50mm C.A.

and 71mm C.A ring mounts (**1**) have a 3.3mm internal diameter. The Pitched Circle Diameter (P.C.D.) for the centre points of the fixing holes are as follows for each ring mount size:-

For 25mm C.A mount – P.C.D is 35mm (I.D. 2.8mm)
For 38mm C.A mount – P.C.D is 47mm (I.D. 2.8mm)
For 50mm C.A mount – P.C.D is 60mm (I.D. 3.3mm)
For 71mm C.A mount – P.C.D is 81mm (I.D. 3.3mm)

If a GS57010 Series polarizer is mounted via use of the fixing holes (**4**) in the ring mount (**1**) alone, the polarizer can be fitted in a parallel or perpendicular orientation for the deposited polarizer grid on the substrate (**2**).

Fitting in the GS57340 Series Rotator Mounts

If a particular angle of polarized light between 0° and 90° is required to be set for a spectral measurement, the GS57010 Series polarizers have been specifically designed for mounting via the aluminium ring mount (**1**) into a GS57340 Series rotator mount

The GS57340 Series rotator mounts are provided in four different sizes and each rotator mount is dedicated to the particular size of GS57010 Series polarizer for its ring mount and C.A dimensions. If a Standard Infrared Polarizer Kit has been purchased a GS571010 Series polarizer and its dedicated GS57340 Series rotator mount will be supplied.

P/N GS57340 Rotator is for GS57010 Series polarizers of 25mm C.A.
P/N GS57350 Rotator is for GS57010 Series polarizers of 38mm C.A.
P/N GS57360 Rotator is for GS57010 Series polarizers of 50mm C.A.
P/N GS57370 Rotator is for GS57010 Series polarizers of 71mm C.A.

Instructions of how to fit and use a GS57010 Series polarizer in its own dedicated GS57340 Series rotator mount are to be found in the rotator mounts own user instruction manual.

General Cautions and Care of the Polarizer

The GS57010 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 Standard Infrared Polarizer Kit was supplied, the GS57010 Series polarizer may be kept fitted into the dedicated GS57340 Series rotator mount and the whole assembly of parts can be stored in the supplied plastic carry case.

5. Legend – Bubble Part Number Identification

(**1**) Anodized aluminium ring mount of GS57010 Series polarizers.
(**2**) Polarizer substrate material.
(**3**) 'V' notch mark on ring mount.
(**4**) Fixing hole on ring mount.

6. Parts for GS57010 Series Polarizers

Polarizers and Polarizer Kits

There are many configurations of GS57010 Series polarizer options available of **Standard**, **HER** and **IQ** versions for a particular substrate and ring mount size.

Please consult the Specac catalogue or website for an appropriate part number for a particular version of GS57010 Series polarizer or a Standard Infrared Polarizer Kit.

GS57340 Series Rotator Mounts For GS571010 Series Polarizers

P/N GS57340 Rotator is for GS57010 Series polarizers of 25mm C.A.
P/N GS57350 Rotator is for GS57010 Series polarizers of 38mm C.A.
P/N GS57360 Rotator is for GS57010 Series polarizers of 50mm C.A.
P/N GS57370 Rotator is for GS57010 Series polarizers of 71mm C.A.

7. Substrate Material Safety Information

KRS-5 Substrate Material – e.g. P/N GS57010 (25mm C.A.)

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^2.
Refractive Index: 2.38 (at 2000cm-1 - wavenumbers).
Spectroscopic transmission range: 17,000 to 250 cm-1 (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 – e.g. P/N GS57070 (25mm C.A.)

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 x 10^{-56} mm Hg at 25°C.
Specific gravity: 5.323 g cm^{-3}.
Solubility in water: Insoluble
Hardness: 780 Kg/mm^2.
Refractive Index: 4.01 (at 2000cm-1 - wavenumbers).
Spectroscopic transmission range: 5,500 to 500 cm-1 (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_2 Substrate Material – e.g. P/N GS57080 (25mm C.A.)

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: CaF2.
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^2.
Refractive Index: 1.40 (at 2000cm-1 - wavenumbers).
Spectroscopic transmission range: 77,000 * to 900 cm-1 (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_2 Substrate Material – e.g. P/N GS57090 (25mm C.A.)

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: BaF2.
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^2.
Refractive Index: 1.45 (at 2000cm-1 - wavenumbers).
Spectroscopic transmission range: 66,666 * to 800 cm-1 (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 – e.g. P/N GS57050 (25mm C.A.)

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^2.
Refractive Index: 2.43 (at 2000cm-1 - wavenumbers).
Spectroscopic transmission range: 20,000 to 500 cm-1 (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 (H2Se) 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.

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