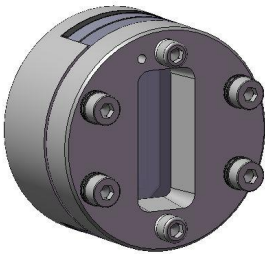




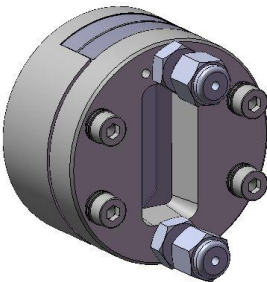
# Liquid Sample Cells GS20500, GS20510, GS20560, GS20570, GS20580 and GS20590 Series

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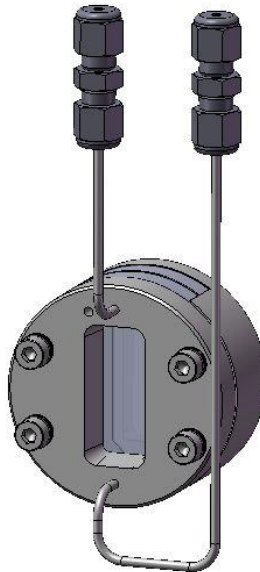
## *User Manual*



**GS20500/20510 Series**



**GS20570/20580 Series**



**GS20560/20590 Series**



Liquid Sample Cells GS20500,  
GS20510, GS20560, GS20570,  
GS20580 and GS20590 Series

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*User Manual*

# *Liquid Sample Cells GS20500, GS20510, GS20560, GS20570, GS20580 and GS20580 Series*

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## **CONTENTS**

|  |    |
|--|----|
| 1. INTRODUCTION .....  | 3  |
| 2. SAFETY CONSIDERATIONS .....                                 | 5  |
| 3. CHECKLIST OF CONTENTS.....                                  | 6  |
| 4. THE STATIC LIQUID SAMPLE CELLS GS20500 AND GS20510 SERIES 7 |    |
| BELVILLE SPRING WASHERS ON M3 CAP HEAD FIXING BOLTS.....       | 10 |
| BUILDING (CONSTRUCTION) OF DEMOUNTABLE CELL SERIES TYPES .     | 11 |
| FILLING THE STATIC LIQUID SAMPLE CELLS .....                   | 13 |
| THERMOCOUPLE WELL HOLE .....                                   | 15 |
| 5. THE FLOW LIQUID SAMPLE CELLS GS20560 AND GS20590 SERIES     | 17 |
| 6. THE FLOW LIQUID SAMPLE CELLS GS20570 AND GS20580 SERIES     | 19 |
| 7. USE OF THE LIQUID SAMPLE CELL SERIES.....                   | 21 |
| CHOICE OF PATHLENGTH SPACER TO USE.....                        | 21 |
| VOLUMES OF DIFFERENT PATHLENGTH LIQUID CELLS .....             | 22 |
| PRESSURE LIMITS FOR FLOW LIQUID SAMPLE CELLS.....              | 23 |
| 8. CLEANING AND CARE OF THE LIQUID SAMPLE CELL SERIES.....     | 24 |
| NOTES ON CLEANING.....   | 25 |
| DATASHEET FOR SODIUM CHLORIDE MATERIAL.....                    | 27 |
| DATASHEET FOR POTASSIUM BROMIDE MATERIAL.....                  | 28 |
| DATASHEET FOR CALCIUM FLUORIDE MATERIAL .....                  | 29 |
| DATASHEET FOR BARIUM FLUORIDE MATERIAL.....                    | 30 |
| DATASHEET FOR ZINC SELENIDE MATERIAL .....                     | 31 |
| DATASHEET FOR SILICON DIOXIDE MATERIAL.....                    | 32 |
| 9. SPARE PARTS OF THE LIQUID SAMPLE CELL SERIES.....           | 33 |

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# 1. Introduction

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Thank you for purchasing a Specac product.

Specac offers a range of **transmission** Liquid Sample Cells that can be used for the study of liquid samples under static or flow conditions at varying temperatures via transmission spectroscopy ranging from the Far UV through to the Far IR. (A comprehensive list of IR transmitting materials and their properties can be found at the back of the Specac catalogue.)

The Liquid Sample Cells are offered under a “family” Series as follows:

- Heatable Sealed Liquid Cells P/N GS20500 Series.
- Heatable Demountable Liquid Cells P/N GS20510 Series.
- Heatable Flow Sealed Liquid Cells P/N GS20560 Series.
- Heatable Flow Sealed Liquid Cells P/N GS20570 Series.
- Heatable Flow Demountable Liquid Cells P/N GS20580 Series.
- Heatable Flow Demountable Liquid Cells P/N GS20590 Series.

In respect of a particular window material being fitted into the Liquid Sample Cell type as supplied, the specific part number of a cell assembly determines the **window material** fitted. E.g. P/N GS20500 is a heatable, sealed cell with NaCl windows, whereas P/N GS20502 is a heatable, sealed cell with CaF<sub>2</sub> windows. The **pathlengths** of the cells under the same part number may differ though.

The Liquid Sample Cells above can be used within a variety of cell mount holder/accessories to allow for their operation under the specific temperature conditions that is offered by the respective mount holder/accessory.

For ambient temperature work, all of the above Series of transmission Liquid Sample Cells can be used in the Ambient Temperature Cell Holder P/N GS20740.

## Liquid Sample Cells GS20500/10/60/70/80/90 Series

For temperature work over the range of ambient to circa 90°C, all of the above Series of transmission Liquid Sample Cells can be used in the Water Heating Jacket Accessory P/N GS20710.

For temperature work over the range of ambient to circa 250°C, all of the above Series of transmission Liquid Sample Cells can be used in the Electrical Heating Jacket Accessory P/N GS20730.

For temperature work over the range of -70°C to circa 250°C, all of the above Series of transmission Liquid Sample Cells, **except** the GS20570/20580 Series Flow Cells, can be used in the Variable Temperature Cell Accessory P/N GS21525.

### Compatibility of Liquid Sample Cell Series Type with a Cell Mount Holder/Accessory

| Liquid Cell Series Type | Mount GS20740 | Mount GS20710 | Mount GS20730 | Mount GS21525 |
|-------------------------|---------------|---------------|---------------|---------------|
| GS20500                 | YES           | YES           | YES           | YES           |
| GS20510                 | YES           | YES           | YES           | YES           |
| GS20560                 | YES           | YES           | YES           | YES           |
| GS20570                 | YES           | YES           | YES           | NO            |
| GS20580                 | YES           | YES           | YES           | NO            |
| GS20590                 | YES           | YES           | YES           | YES           |

This instruction manual is for specific explanation of the transmission Liquid Sample Cell Series types and can be consulted accordingly.

An instruction manual is supplied with each of the cell mount holder/accessory options to explain how any of the liquid transmission cells are to be mounted, installed and used. Therefore, please consult both this instruction manual along with the appropriate instruction manual supplied for the cell mount holder/accessory in any usage.

## 2. Safety Considerations

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With use of any spectroscopic accessory that involves the study of a wide range of chemical samples, the associated risk in handling may mostly be attributed to the specific sample type to be handled itself. As far as it possible you should follow a procedure for safe handling and containment of the type of sample to be used.

With respect to safety of use specifically for the range of Heatable, Static or Flow, Sealed or Demountable Liquid Cells P/N GS20500/10/60/70/80/90 Series, they use different window materials for containment of a specific liquid sample type within a stainless steel body for the cell itself. As standard, NaCl, KBr, CaF<sub>2</sub>, BaF<sub>2</sub>, ZnSe and UV Quartz windows are the six window materials of choice that can be used.



**Caution:** *Out of these six different window types, ZnSe is the most potentially hazardous material with respect to toxicity risk in use and handling.*

NaCl, KBr, CaF<sub>2</sub>, BaF<sub>2</sub> and UV Quartz window materials can be considered relatively safe to use, although all of them may be harmful to the body if ingested in significant quantity. The general rule when working with **any** window/crystal material (and sample) **is to always wear gloves and safety gear** (e.g. safety spectacles) when handling to obviate the risk of contact with the skin.

Provided with each fitted window version of a Liquid Cell Assembly is a window material safety data sheet for the specific material itself that can be consulted for safe handling. A copy of each of these datasheets can also be found in this User Instruction Manual in the **Notes On Cleaning** Section found on pages 25 to 32.

### 3. Checklist of Contents

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On receipt, check that the following items have been supplied:

- The appropriate transmission Liquid Sample Cell supplied as its Series (family) type.

The supplied Liquid Sample Cell type cell will include the choice of window material fitted (check against the part number - e.g. P/N GS20511 is a heatable, demountable cell with KBr windows) and the pathlength of the cell specified from the order. The Liquid Sample Cell will be supplied fully assembled for immediate use.

- An instruction manual for use of the transmission Liquid Sample Cell Series type.
- An Essential Spares Kit of parts (P/N GS20538 for Static, **Sealed** Cell Series types, P/N GS20539 for Static, **Demountable** Cell Series types and P/N GS20569 for Flow, **Demountable** Cell Series types).
- Any additional parts supplied in conjunction with the transmission Liquid Sample Cell Series type.

(See specific section in this manual to identify parts that are supplied.)

- Any additional cell mount holder/accessory that has been ordered for use with the transmission Liquid Sample Cell Series type.
- Instruction manual for any additional cell mount holder/accessory.

Carefully remove the specific parts from their packaging and follow the explanation for use of the Liquid Sample Cell Series type from the appropriate section(s) within this instruction manual.

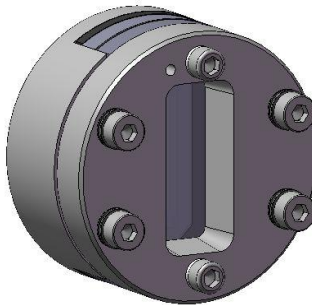


## 4. The Static Liquid Sample Cells GS20500 and GS20510 Series

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### **Basic Construction of the Liquid Sample Cells**

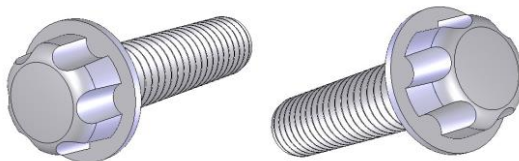
All of the **Liquid Sample Cell Series types** are based on the construction configuration of the GS20500 and GS20510 Series cells. (See **Fig 1.**) The Cell Series types differ by having alternative front plate assemblies for construction of the liquid cells, to offer either **static** (non-flow of a liquid sample) or liquid **flow** versions of the cells. There are two basic types of static cells and four basic types of flow cells. An overall construction of the static Liquid Sample Cell types is seen as a front view from **Fig 1.** (***Demountable type cell shown.***)



**Fig 1. GS20500 and GS20510 Series Heatable, Static, Liquid Cell**

The **GS20500 Series static** cells are fully **sealed** liquid cell assemblies, whereby the front plate (1), top gasket (2 - in lead material), front window (3 - with drilled holes), pathlength spacer (4 - in lead material) and rear window (5 - undrilled) are all fused/sealed together from an amalgamation process. (The components of the cell are seen as an exploded diagram from **Fig 3.**) These liquid cell components are held compressed within the body (6) of a sealed cell assembly by four **tamperproof** M3 x 12mm screw bolts (7) between the front plate (1) and the body (6), but fundamentally the amalgamation process will ensure that the cell components remain sealed together, such that they cannot be easily separated.

The tamperproof M3 x 12mm screw bolts (7) are shown as **Fig 2**. They require a special tool for fitting and this means that these bolts (7) can be neither tightened or loosened when an appropriate sealed cell assembly (static or flow Series cell) has been supplied as ordered for its particular combination of windows and pathlength spacer setting.



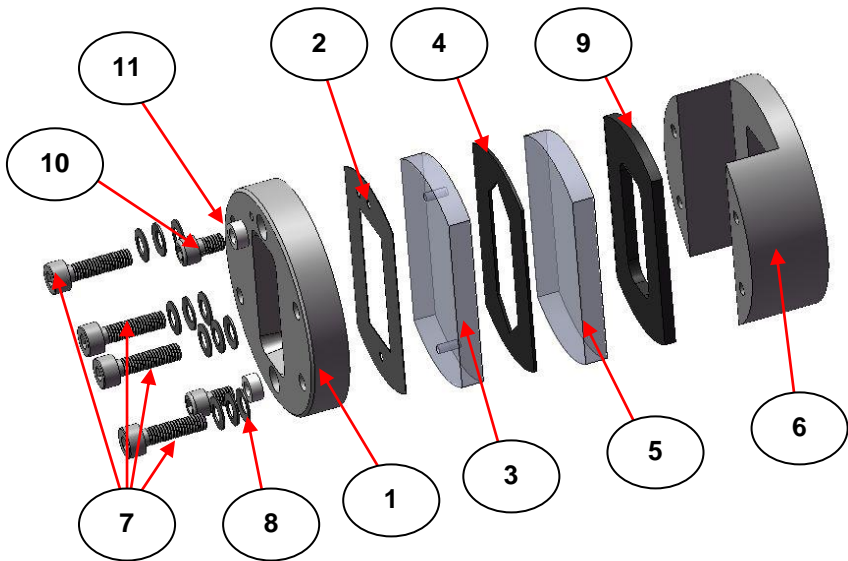
**Fig 2. Tamperproof Screw Bolt Used in Sealed Cell Assemblies**

The pathlength versions for sealed cells offered from the lead spacers are fixed (nominally close) to 0.025, 0.05, 0.10, 0.20, 0.50 and 1.00 mms.

**Note:** *Provided with all **Sealed type cells** from the GS20050, GS20560 and GS20570 Series is a unique **serial number** for identification of the cell assembly. The serial number takes the form of a five figure number preceded by a letter (e.g. P12345) and has been electrochemically printed onto the cell bodywork.*

Because tamperproof screw bolts (7) have been used in their construction and serial number identification has been given to **sealed type cells only**, this means that sealed cell assemblies have been designed **not to be disassembled** by the user/operator in the same way that a demountable cell can be used.

A fully sealed cell helps to maintain the integrity of the sealing capability for the cell assembly as provided, fully constructed and leak tested (with air) from new. Consequently, sealed liquid cells offer the best chance of containment of a liquid sample (particularly volatile solvents/solutions) with a minimum risk of leakage of the sample from the cell environment. As such, sealed versions of the Liquid Sample Cell Series types are preferentially used in the Variable Temperature (VT) Cell Holder P/N GS21525, because of the vacuum environment operating requirement of this particular liquid cell holder accessory.



**Fig 3. “Exploded” View of GS20500 and GS20510 Liquid Sample Cells for Their Components**

Using **Fig 3.** as an example to follow, the **GS20510 Series static** cells are **demountable** liquid cell assemblies, whereby the front plate (**1**), top gasket (**2** - in PTFE material), top window (**3** - with drilled holes), pathlength spacer (**4** - in Mylar™ or PTFE material) and lower window (**5** - undrilled) are all compressed together by **tightening** of the four M3 x 12mm cap head bolts (**7**) between the front plate (**1**) and the body (**6**).

**Note:** The M3 x 12mm cap head bolts (**7**) used in a demountable cell assembly are **not tamperproof bolts** as used in sealed cell assemblies. They can be tightened or loosened by use of an appropriate size Allen key.

**No amalgamation** process is used to seal the window/cell components together, hence a demountable cell can be deconstructed

## Liquid Sample Cells GS20500/10/60/70/80/90 Series

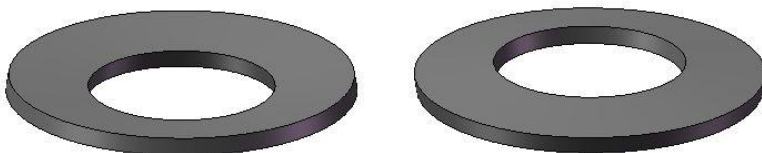
and rebuilt by the user to form a different version of cell from alternative window materials and pathlength spacers.

The pathlength versions for demountable cells offered by the spacers are fixed (nominally close) to 0.006, 0.012 and 0.025mm from Mylar™ material and 0.05, 0.10, 0.20, 0.50 and 1.00mm from PTFE material. Demountable version cells offer certain flexible advantages over their sealed cell equivalents in the way that different windows and spacers can be used in the basic metalwork assembly of the cell constructions.

Having stated that **sealed** version Liquid Sample Cells are preferred to be used in the VT Cell Holder P/N GS21525, for Liquid Sample Cell Series types that require pathlengths shorter than 0.025mm, Mylar™ material at 0.006 or 0.012 mms nominal gauge thickness has to be used in a liquid cells construction. This material cannot be amalgamated for sealing, so very short pathlength liquid cells are **demountable** by nature.

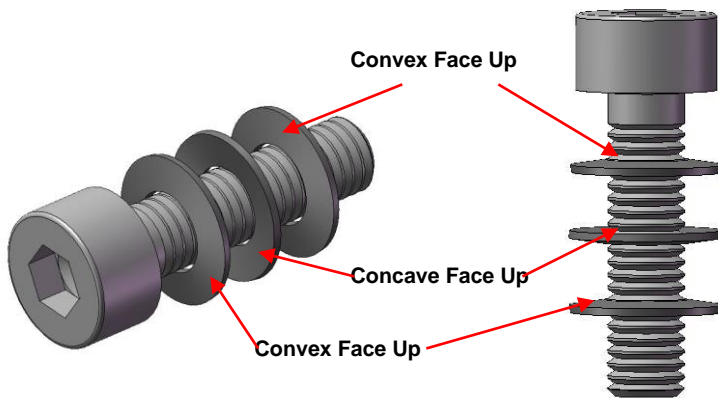
### “Belville” Spring Washers on M3 x 12mm Fixing Bolts

In **Fig 3**, for an exploded view of the basic assembly of the Liquid Sample Cell types, on each of the four M3 x 12mm fixing bolts (7), whether they be tamperproof or cap head bolts, three “Belville” spring washers (8) are used to assist with the correct tightening and overall sealing for the components of the liquid cell assembly. These bolt and washer assemblies work in conjunction with the rear aluminium 2mm thick gasket/packing spacer (9), to allow for sufficient expansion or contraction of the components of the sealed or demountable cell assembly when used at temperatures other than ambient.



**Fig 4. “Belville” Spring Washers – Concave Face Uppermost (Left) and Convex Face Uppermost (Right)**

**Fig 4.** shows that the Belville spring washers (8) used are “dish shaped” in their structure, such that when they are laying flat on a level surface the uppermost face of the washer will be either concave or convex in nature. In construction of a bolt (7) and three spring washer (8) assembly when rebuilding a **demountable liquid cell** it is very important that the spring washers are placed in an alternating convex face up/concave face up/concave face up construction on the bolt. Please see **Fig 5.** to show the sequence of each spring washer on each bolt assembly.



**Fig 5. Arrangement of the 3 Belville Spring Washers for Each M3 x 12mm Fixing Bolt Assembly.**

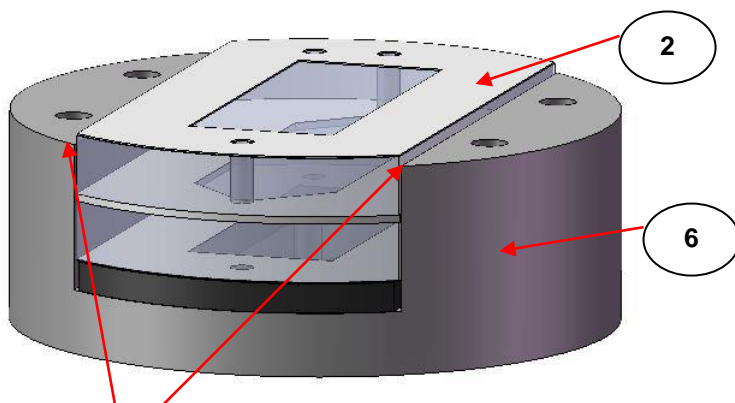
### **Building (Construction) of Demountable Cell Series Types**

The overall sealing capability of the constructed cell is dependent upon the surface quality of the window faces and the quality of spacer and gasket components. Window materials have their own physical characteristics; some are soft and can deform, others are hard and brittle. It is a matter of practice and familiarity with the cells and specific window material that determines the ideal sealing conditions.

A recommended method for assembly of a demountable cell is to place the body (6) onto a flat surface. Build up the components as in the

diagram from **Fig 3**, using your choice of window materials (**3** and **5**) and thickness of spacer (**4**).

**Note:** Depending upon the thickness of the spacer and cell windows there **must** be a sufficient gap between the body (**6**) and underside of the front plate (**1**) to allow for the cell components to be tightened together (see **Fig 6**). A sufficient gap can be created if thin windows and a short pathlength spacer are used by placing additional packing spacers between the rear gasket/packing spacer (**9**) and body (**6**).



Note distance between top of window and PTFE gasket with the body (**6**) to allow for cell components to seal when front plate (**1**) is bolted into position

**Fig 6. View of Demountable Cell Components with Front Plate (1) Removed**

When the cell has been built to a level similar to that seen in **Fig 6**, place the front plate (**1**) over the assembly. Be very careful not to displace/move the top PTFE gasket (**2**) out of alignment from the top window. When each fixing bolt (**7**) has been fitted with the correct sequence of spring washers (**8**), place these into their hole positions on the front plate (**1**) and apply an even pressure over the whole assembly.

Initially, screw each of the fixing bolts (**7**) in a “diagonally opposite” sequence into the body (**6**) to finger tightness until the spring washers

(8) begin to compress. The diagonal sequence of tightening allows for the front plate (1) to be evenly compressed over the cell components. All of the components in the cell will now be loosely held together.

To tighten the components fully together, use the M3 Allen Key in the fixing bolts (7), turning each bolt slowly in the diagonally opposite sequence. It must be emphasised that one should be very careful not to overtighten the bolts (7) to obtain a sufficient seal for the demountable cell components, as there is risk of damage/breakage to the window material.

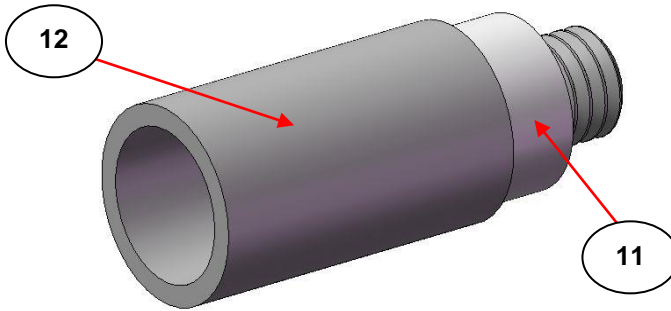
**Note:** *It is usually a matter of experience and familiarity with certain window materials in their specific cell construction that determines the tightness of the bolts. **Specac cannot be held responsible for any accidental damage or breakage of a window material due to the effects of over-tightening.***

## **Filling the Static Liquid Sample Cells**

### **Filling Cap Bolt and PTFE Washer**

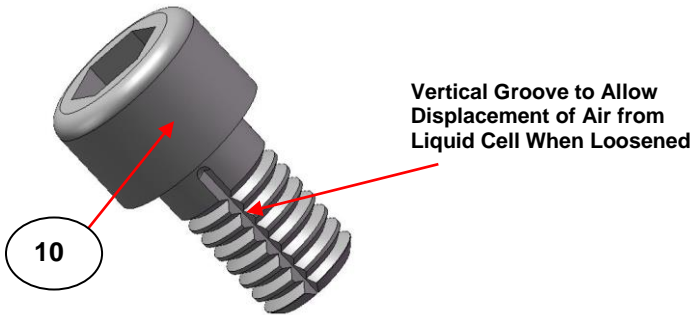
For the static Liquid Sample Cells Series types only (for both sealed and demountable types), the front plate (1) has two M3 x 6mm filling cap head bolts (10) that fit into their own PTFE sealing washers (11). (See **Fig 3.**) To introduce a liquid sample into the sample cell cavity created from the windows and spacer pathlength construction, one of these M3 filling cap head bolts (10) is unscrewed/removed from the front plate (1) using an Allen key. (The PTFE washer (11) may also be removed when the bolt is removed.)

The liquid cell can be filled with a liquid sample via a syringe fitted with a sufficient size needle that can be passed through the filling hole of the front plate (1) from where the filling cap bolt has been removed. Alternatively, the threaded Luer fitting (12) that is supplied with the liquid cell can be screw thread fitted into the hole of the front plate and then the cell can be filled via a compatible Luer fitting syringe. (See **Fig 7.** to show the threaded Luer fitting.) For screwing the threaded Luer into the hole position, a sealing washer (11) is also required.



**Fig 7. Threaded Luer Fitting to Fill the Static Liquid Sample Cells**

The M3 filling cap head bolt (10) itself is special in that it has a fine groove milled vertically along the threaded shaft. (See Fig 8.)



**Fig 8. M3 Filling Cap Head Bolt**

When filling the liquid cell either via a syringe with a needle or via the Threaded Luer fitting (12), the M3 cap head bolt (10) remaining in the front plate (1) does not have to be removed completely. It is sufficient to loosen this cap head bolt slightly by a couple of turns from sealing with its PTFE washer (11). This will expose the groove to allow for a flow of air that will be displaced from the cell cavity when it is being filled with liquid.



To fill the liquid cell, place the cell assembly on a flat surface. If possible, when filling, look at the surface of the front window (3) into the cell to see the meniscus “front” of solvent or solution that will flow to fill the cavity of the cell, to ensure that the liquid cell is filling. When the cell has been filled with sufficient fluid, the loosened M3 filling cap bolt (10) is retightened, and the removed M3 filling cap bolt (10) is replaced into the front plate (1) and tightened to seal. (Swap over the threaded Luer fitting (12) if this has been used to fill the liquid cell.)

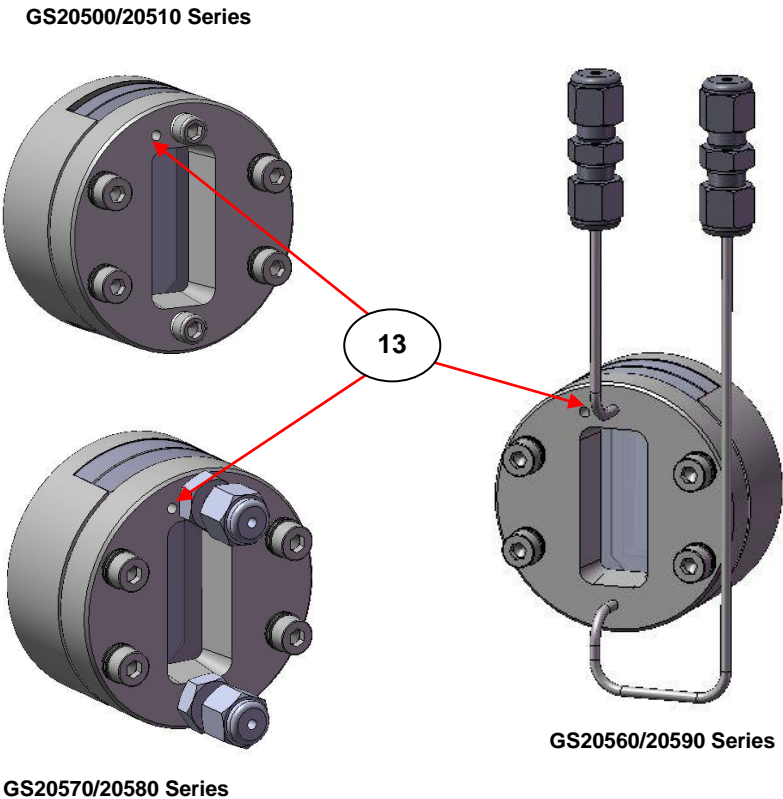
The static Liquid Sample Cell (either GS20500 or GS20510 Series type) is now ready for use, to be mounted in a specific mount holder or heating accessory to be installed into a spectrometer for spectral analysis.

## **Thermocouple Well Hole**

On **all** of the Liquid Sample Cell Series types, there is a small thermocouple well hole (13) in the front plate (1) that allows for installation of a thermocouple to monitor the temperature of the liquid cell and the sample. (See **Fig 9**.)

If the Liquid Sample Cell types (that are compatible) are being used in the Electrical Heating Jacket P/N GS20730, the controlling thermocouple of this heating accessory must be placed within the thermocouple well hole (13) to allow for correct heating control. However, for use of any of the Liquid Sample Cell types in the Ambient Temperature Cell Holder P/N GS20740, the Water Heating Jacket P/N GS20710 or the Variable Temperature Cell GS21525, a T-type monitoring thermocouple assembly (Specac P/N GS20200) may be introduced into the thermocouple well hole (13) to read the actual temperature.

Installation of the Liquid Sample Cell Series type into the specific cell mount holder/accessory to be used is explained from the instruction manual supplied with the mount holder/accessory.

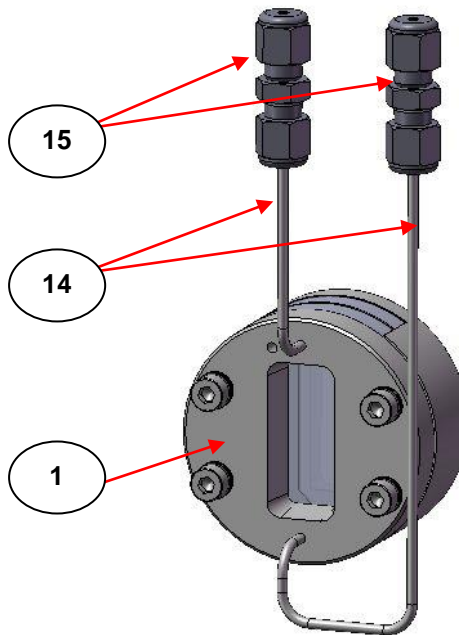


**Fig. 9. Position of Thermocouple Well Hole on the Liquid Sample Cell Series Types**

## 5. The Flow Liquid Sample Cells GS20560 and GS20590 Series

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The Flow Liquid Sample Cells GS20560 and GS20590 Series are respectively based upon the standard static GS20500 and GS20510 Series cells for their construction, but the front plate (1) is different. (See **Fig 10.**)



**Fig 10. Flow Liquid Sample Cell GS20560 and GS20590 Series**

The M3 Filling cap head bolts (10) and their washers (11) have been replaced by 1/16" O.D. stainless steel flow tubes (14) that have been brazed into the sample introduction holes on the front plate (1). The

## **Liquid Sample Cells GS20500/10/60/70/80/90 Series**

flow tubes (**14**) have been specifically routed (shaped) to finish at a certain distance away from the front flow plate (**1**) and above the Liquid Sample Cell assembly when the cell is in a horizontal aspect.

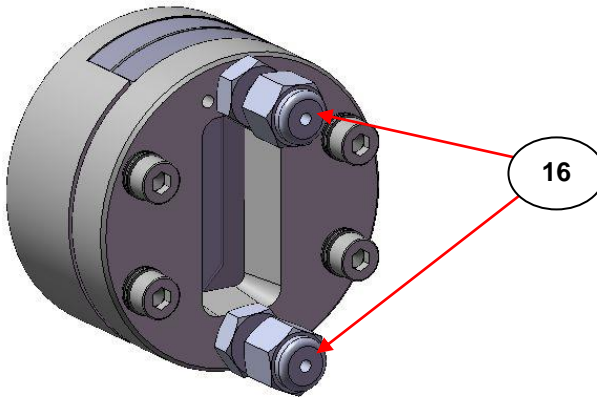
As standard these Flow Liquid Sample Cell Series types have 1/16" Swagelok® union connections (**15**) fitted to the flow tubes (**14**) for connectivity to similar 1/16" O.D. gauge tubing (ferrule and olive compression fitting) from a liquid sample pumping delivery system.

Sealed (GS20560 Series) and demountable (GS20590 Series) versions of these flow cells are available. They have been specifically designed for use in the Variable Temperature Cell Holder P/N GS21525, because the routing of the 1/16" stainless steel flow tubes allows for installation of these liquid flow cells into the vacuum jacket body of this heating mount accessory. The GS20560 and GS20590 Series flow cells can also be used in the Electrical Heating Jacket P/N GS20730, Ambient Temperature Holder P/N GS20740 and Water Heating Jacket P/N GS20710. (See compatibility graph page 4).

## 6. The Flow Liquid Sample Cells GS20570 and GS20580 Series

---

The Flow Liquid Sample Cells GS20570 and GS20580 Series are respectively based upon the standard static GS20500 and GS20510 Series cells for their construction, but the front plate (1) is different. (See **Fig 11.**)



**Fig 11. Flow Liquid Sample Cell GS20570 and GS20580 Series**

The M3 Filling cap head bolts (10) and their washers (11) have been replaced by 1/16" Swagelok® union connections (16) that have been fitted into the sample introduction holes on the front plate (1).

These flow Liquid Sample Cells also differ from the GS20560 and GS20590 Series flow cells in having the 1/16" Swagelok® union connections fitted directly to the front plate (1) without the use of connecting 1/16" O.D. stainless steel tubing in between. To introduce a liquid sample into the flow cell, 1/16" O.D. tubing is connected to the Swagelok® union connections (16) and flowed from a liquid sample pumping delivery system.

## Liquid Sample Cells GS20500/10/60/70/80/90 Series

Sealed (GS20570 Series) and demountable (GS20580 Series) versions of these flow cells are available. Unlike the GS20560 and GS20590 flow cells, the GS20570 and GS20580 flow cells **cannot** be used in the Variable Temperature Cell Holder P/N GS21525, because the Swagelok® union connections (**16**) on the front plate do not allow for sufficient room to fit and route appropriate 1/16" O.D. tubing within the Variable Temperature Cell Holder vacuum jacket.

However, the GS20570 and GS20580 Series flow cells can be used in the Electrical Heating Jacket P/N GS20730, Ambient Temperature Holder P/N GS20740 and Water Heating Jacket P/N GS20710. (See compatibility graph page 4).

## 7. Use Of Liquid Sample Cells

### GS20500/10/60/70/80/90 Series

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#### Choice of Pathlength Spacer to Use

The choice of pathlength for a liquid cell is determined by the concentration of solution to be analyzed.

For the purposes of explanation here, an analytical concentration of 100% for a solution is deemed to be when a particular solid is no longer soluble in a given volume of solvent at a particular temperature and pressure. In essence a saturated solution occurs. A 10% analytical concentration would be an amount of the saturated solution diluted ten times by the same solvent.

Typically, for all versions of Specac GS20500, GS20510, GS20560, GS20570, GS20580 and GS20590 Series liquid cells, the pathlength of spacer to use for IR determination will fall into the following ranges:-

| Analytical Concentration | Typical Pathlength             |
|--------------------------|--------------------------------|
| Greater than 10%         | 0.05mm (50 microns) or shorter |
| 10% to 1%                | 0.10mm (100 microns)           |
| 1% to 0.1%               | 0.20mm (200 microns)           |
| Less than 0.1%           | 0.50mm (500 microns) or longer |

The pathlength spacers for all the liquid cells are in lead material (for sealed cells) and PTFE or Mylar material (for demountable cells.) All spacer pathlengths quoted are nominal values. In the process for making sealed window assemblies or in construction of demountable cells, the actual pathlength can vary slightly from the nominal value. The thinnest pathlength cells at 0.006mm (6 microns) and 0.012mm (12 microns) are only obtainable with Mylar as the spacer material. They are classed as demountable cells because the windows cannot be permanently sealed together when using Mylar as the spacer. The thinnest sealed cells with lead spacers are at a nominal pathlength of 0.025mm (25 microns).

## Liquid Sample Cells GS20500/10/60/70/80/90 Series

For sealed window assemblies that are supplied by Specac using a lead spacer, the pathlength is measured after manufacture, but the accuracy of this measurement varies with pathlength and the type of window material. For small pathlengths (e.g. 0.1mm) the values are typically within one or two microns. The accuracy may be lower for longer pathlengths. In applications where the cell pathlength is critical it should be periodically checked using the fringe counting method described below.

The tolerance limits on PTFE and Mylar spacers used for demountable cells cannot be universally applied, because of the wide range of window material and spacer combinations available for construction by an individual user. When constructing a demountable cell, you should always measure the pathlength of an empty cell by calculation from the fringing pattern produced in the IR spectrum.

From the fringing pattern obtained, the thickness of the cell can be calculated from the following formula.

$$t = \frac{10 \ n}{2(f_1 - f_2)}$$

Where t = thickness in millimeters (cell pathlength).

n = number of fringes (peak to peak measurement).

f<sub>1</sub> = frequency at first peak (wavenumber position).

f<sub>2</sub> = frequency at second peak (wavenumber position).

## Volumes of Different Pathlength Liquid Cells

The volume of liquid that can be contained and analysed in these various Liquid Sample Cells is calculated from the aperture area and thickness of the type of spacer that is used to create the liquid cavity between the windows in the cell. The approximate area for the spacer used in the GS20500/20510 Series type cells is 270 mm<sup>2</sup>. The thickness of a spacer provided as standard varies from a minimum of 0.006 mm to 1.00 mm. Hence for each version of liquid cell at a particular pathlength (thickness of spacer) the volumes are as follows:



**For Liquid GS20500/20510 Series Cells (Rectangular windows – top drilled, bottom undrilled)**

Mylar spacer 0.006 mm thick. Volume is 1.60 microliters.

Mylar spacer 0.012 mm thick. Volume is 3.25 microliters

Mylar or lead spacer 0.025 mm thick. Volume is 6.80 microliters

PTFE or lead spacer 0.05 mm thick. Volume is 13.50 microliters

PTFE or lead spacer 0.10 mm thick. Volume is 27.00 microliters

PTFE or lead spacer 0.20 mm thick. Volume is 54.00 microliters

PTFE or lead spacer 0.50 mm thick. Volume is 135.00 microliters

PTFE or lead spacer 1.00 mm thick. Volume is 270.00 microliters

**Note:** *The figures produced are for an approximate volume of liquid contained between the window faces only. It does not include any extra amount of liquid that may be contained in the filling port sections of either type of liquid cell.*

**Pressure Limits for Flow Liquid Sample Cells**

The **sealed**, flow liquid cells as GS20560 and GS20570 Series cells are supplied already constructed and sealed together. These flow cells **cannot be deconstructed** without risk to the sealing integrity of the windows, lead spacer and gasket components. In flow purpose use, their pressure rating is circa 5 to 6psi above atmospheric pressure conditions, before there may be a risk of leakage.

Similarly, the **demountable**, flow liquid cells as GS20580 and GS20590 Series cells are supplied already constructed and sealed together, but because these flow cells have been designed to be deconstructed for flexibility of use with different windows and spacer components, the sealing integrity of these cells is dependent upon a subsequent re-build of the components by the user. From an initial factory supply of the demountable flow cells, their pressure rating is circa 5 to 6psi above atmospheric pressure conditions, before there may be a risk of leakage.

## 8. Cleaning and Care of the Liquid Sample Cells GS20500/10/60/70/80/90 Series

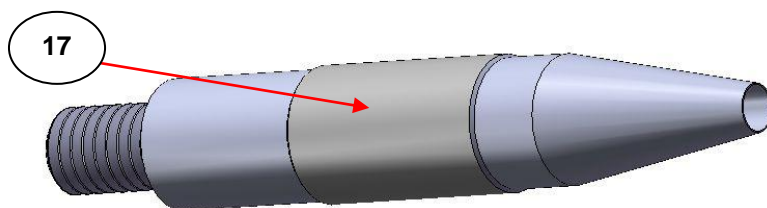
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To clean a **demountable window assembly** of a GS20510, GS20580 and GS20590 Series liquid cell, you have the option of firstly removing as much solvent/solution from the cell cavity as possible using a syringe and:

- 1) Flushing through with a cleaning solvent (if you do not wish to disassemble a cell), or
- 2) Completely disassembling the cell to clean thoroughly the individual components (windows and spacer etc).

To clean a **sealed window assembly** of a GS20500, GS20560 and GS20570 Series liquid cell (to try and remove any residue or trapped particulates within the cell), you can firstly remove as much solvent/solution as possible from the cell cavity using a syringe, but you cannot dis-assemble the cell to break the sealed window units apart. However, it is possible to clean the cell by flushing through with an appropriate solvent and therefore maintain the sealing integrity of the cell.

Included with the GS20500 and GS20510 Series static liquid cells is an additional threaded flushing tube (**17**). (See **Fig 12**).



**Fig 12. Flushing Tube Used to Clean GS20500 and GS20510 Series Static Liquid Cells**

To clean a static sealed cell GS20500, or if you do not wish to disassemble a demountable GS20510 Series cell, the flushing tube (17) can be screwed into one of the sample introduction ports in place of the M3 x 6mm filling cap head bolt (10). The other cap head bolt (10) is removed and the threaded Luer fitting (12) is placed into this sample port position.

Fix a small length of silicone type flexible tubing to the flushing tube (17) and then place the outlet of the tubing in a beaker. (Ensure the flushing tube also has a PTFE sealing washer (11) attached to the threaded connection when screwing into the front plate (1).) A cleaning solvent can then be introduced into the cell from a Luer connection type syringe via the Luer fitting (12) and the flushings are collected in the beaker.

Flush through with clean solvent 3 or 4 times (however much is necessary). Remove the Luer syringe from the Luer fitting (12) and the tubing from the flushing tube (17) and you may then apply a vacuum suction line over one of the ports to draw air into the cell cavity to dry out the remaining traces of solvent. (Run a spectrum of the empty cell (or filled with neat solvent) to check for cleanliness.)

If necessary, as an alternative to flushing through, the cell can be filled with neat solvent and left to stand for a few minutes so that any awkward trapped particulates can be allowed to dissolve in the solvent. Ejection of these washings and subsequent cleaning and checking is the same as described above.

When **any** of the liquid cell types have been cleaned, they can be stored appropriately in a dry environment. If you are using window materials in a **demountable** cell type that are susceptible to moisture attack etc, then it may be necessary to disassemble the cell fully and store the cell components accordingly safely.

## Notes On Cleaning

When cleaning any window material being used in the range of Heatable, Static or Flow, Sealed or Demountable Liquid Cells P/N GS20500/10/60/70/80/90 Series, it is **very important to take care** to

avoid damage to the window materials. As also mentioned in the Safety Considerations (Section 2, page 5), of the six standard window materials supplied that can be fitted into these liquid cells, ZnSe is potentially the most hazardous in terms of risk of toxicity if it comes into contact with the skin.



**Note:** *Always wear gloves to protect yourself and the window material.*

Solvents such as water, methanol, acetone, hexane, chloroform etc are suitable to use for cleaning purposes, but avoid use of any solvents that are “wet” or contain trace amounts of water, as NaCl and KBr window materials will be damaged. CaF<sub>2</sub>, BaF<sub>2</sub>, ZnSe and UV Quartz window materials are generally chemically tolerant of a wide range of aqueous based **solutions**, but only sample solutions that fall within the pH range of pH5 to pH9 are tolerated by the ZnSe window material. Stronger acids and bases if introduced into the Liquid Cell Assemblies will irreparably damage any ZnSe windows that are fitted.

**Caution!** *If in doubt that your liquid sample may be damaging to the window material being used within the Liquid Cell Assembly, always try to test a fragment of the window material type, if possible, with the chemical first.*

When wiping away any solid residues (if present) or a viscous liquid sample from a window removed from a **demountable** type cell, use very soft lens tissues to avoid scratches being caused on the surface of the window material. Scratches and blemishes to the window surface will result in poor light throughput for the transmission technique (more risk of light scatter) and an overall degradation in the Liquid Cell Assembly performance.

## Datasheet for Sodium Chloride (NaCl) Material

### General

Synonyms: salt, sea salt, table salt, common salt, rock salt.

When fused together as a solid can be polished and used as a transmission window material. Slightly hygroscopic material similar to Potassium Bromide (KBr).

Soluble in water and glycerine. Slightly soluble in lower order alcohols.

Fairly good resistance to mechanical and thermal shock and can be easily polished.

Molecular formula: NaCl.

Chemical Abstracts Service (CAS) No: 7647-14-5.

### Physical Data

Appearance: Odourless, white or colourless crystalline solid.

Melting point: 804°C.

Boiling point: 1413°C.

Vapour pressure: 1mm Hg at 865°C.

Specific gravity: 2.16 g cm<sup>-3</sup>

Solubility in water: 35.7g/100g at 0°C.

Hardness: 6 Kg/mm<sup>2</sup>.

Refractive Index: 1.52 (at 2000cm<sup>-1</sup> - wavenumbers).

Spectroscopic transmission range: 40,000 to 600 cm<sup>-1</sup> (wavenumbers).

### Stability

Stable. Incompatible with strong oxidising agents.

### Toxicology

Not believed to present a significant hazard to health. May cause eye irritation.

### 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.

## Datasheet for Potassium Bromide (KBr) Material

### General

Medium for making Potassium Bromide pellets for IR spectroscopy.  
When fused together as a solid can be polished and used as a transmission window material. Hygroscopic material similar to Sodium Chloride (NaCl).  
Soluble in water, glycerine and alcohols. Slightly soluble in ether.  
Fairly good resistance to mechanical and thermal shock.  
Molecular formula: KBr.  
Chemical Abstracts Service (CAS) No: 7758-02-3.

### Physical Data

Appearance: Odourless, white or colourless crystalline solid.  
Melting point: 730°C.  
Boiling point: 1380°C.  
Vapour pressure: 1mm Hg at 795°C.  
Specific gravity: 2.75 g cm<sup>-3</sup>.  
Solubility in water: 53.48g/100g at 0°C.  
Hardness: 6 Kg/mm<sup>2</sup>.  
Refractive Index: 1.54 (at 2000cm<sup>-1</sup> - wavenumbers).  
Spectroscopic transmission range: 43,500 to 400 cm<sup>-1</sup> (wavenumbers).

### Stability

Stable. Incompatible with strong oxidising agents, strong acids, bromine trifluoride and bromine trichloride.

### 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.

## Datasheet for Calcium Fluoride (CaF<sub>2</sub>) Material

### 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.)

## Datasheet for Barium Fluoride (BaF<sub>2</sub>) Material

### 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.)



## Datasheet for Zinc Selenide (ZnSe) Material

### 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 5 to 9 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.

## Datasheet for Silicon Dioxide (Quartz) Material

### General

Synonyms: Silica, Fused Silica, Quartz, Fused Quartz, Spectrosil, Suprasil, IR Quartz, UV Quartz

When fused together used as a transmission window material.

Resistant to acids and alkalis and unaffected by most solvents.

Very hard window material and tolerant to thermal and mechanical shock.

Molecular formula:  $\text{SiO}_2$ .

Chemical Abstracts Service (CAS) No: 7631-86-9.

### Physical Data

Appearance: Odourless, white crystalline solid or powder.

Melting point: 1713°C.

Solubility in water: 0g/100g at 0°C.

Hardness: 460 Kg/mm<sup>2</sup>.

Refractive Index: 1.46 (at 2000cm<sup>-1</sup> - wavenumbers).

Spectroscopic transmission range: 59,000 to 3700 cm<sup>-1</sup> (wavenumbers) – UV grade quartz.

50,000 to 3000 cm<sup>-1</sup> (wavenumbers) – IR grade quartz.

### Stability

Stable.

### Toxicology

Not believed to present a significant hazard to health in bulk form. Quartz dust is probably carcinogenic, causing silicosis.

### 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.

## 9. Spare Parts of the Liquid Sample Cells GS20500/10/60/70/80/90 Series

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### Windows for Demountable Cells

P/N GS20520 Pair of NaCl windows.  
P/N GS20521 Pair of KBr windows.  
P/N GS20522 Pair of CaF<sub>2</sub> windows.  
P/N GS20523 Pair of BaF<sub>2</sub> windows.  
P/N GS20596 Pair of ZnSe windows.  
P/N GS20596 Pair of UV Quartz (Fused Silica) windows.

### Spacers and Consumables

P/N GS20040 Front PTFE gasket for demountable liquid cells (10 off).  
P/N GS20050 Assorted spacers consisting of 2 each of 0.006, 0.012, 0.025mm spacers in Mylar material and 2 each of 0.05, 0.10, 0.20, 0.50 and 1.00mm spacers in PTFE material (16 spacers in total)  
P/N GS20070 Packet of 10 spacers at the same pathlength and material chosen from 0.006, 0.012, 0.025mm spacers in Mylar material and 0.05, 0.10, 0.20, 0.50 and 1.00mm spacers in PTFE material.  
P/N GS10030 Flushing tube kit (1 tube and 1 PTFE washer).  
P/N GS10040 Threaded Luer fitting and washer (2 off).  
P/N GS10050 Syringe needles (10 off).  
P/N GS10060 Filling cap head bolt (2 off).  
P/N GS10070 Filling cap head bolt PTFE washer (10 off).

### Liquid Sample Cells Series Types (Complete Assemblies)

#### GS20500 Series (Static, Sealed)

P/N GS20500 Static, sealed cell with **NaCl** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.  
P/N GS20501 Static, sealed cell with **KBr** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.  
P/N GS20502 Static, sealed cell with **CaF<sub>2</sub>** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.  
P/N GS20503 Static, sealed cell with **BaF<sub>2</sub>** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.  
P/N GS20508 Static, sealed cell with **ZnSe** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

### **GS20510 Series (Static, Demountable)**

P/N GS20510 Static, demountable cell with **NaCl** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20511 Static, demountable cell with **KBr** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20512 Static, demountable cell with **CaF<sub>2</sub>** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20513 Static, demountable cell with **BaF<sub>2</sub>** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20519 Static, demountable cell with **ZnSe** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

### **GS20560 Series (Flow, Sealed – for P/N GS21525)**

P/N GS20560 Flow, sealed cell with **NaCl** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20561 Flow, sealed cell with **KBr** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20562 Flow, sealed cell with **CaF<sub>2</sub>** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20563 Flow, sealed cell with **BaF<sub>2</sub>** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20566 Flow, sealed cell with **ZnSe** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

### **GS20590 Series (Flow, Demountable – for P/N GS21525)**

P/N GS20590 Flow, demountable cell with **NaCl** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20591 Flow, demountable cell with **KBr** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20592 Flow, demountable cell with **CaF<sub>2</sub>** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20593 Flow, demountable cell with **BaF<sub>2</sub>** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20594 Flow, demountable cell with **ZnSe** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

### **GS20570 Series (Flow, Sealed – for P/N GS20730)**

P/N GS20570 Flow, sealed cell with **NaCl** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20571 Flow, sealed cell with **KBr** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20572 Flow, sealed cell with **CaF<sub>2</sub>** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20573 Flow, sealed cell with **BaF<sub>2</sub>** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20576 Flow, sealed cell with **ZnSe** windows, with choice of pathlength from 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

### **GS20580 Series (Flow, Demountable – for P/N GS20730)**

P/N GS20580 Flow, demountable cell with **NaCl** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20581 Flow, demountable cell with **KBr** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20582 Flow, demountable cell with **CaF<sub>2</sub>** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20583 Flow, demountable cell with **BaF<sub>2</sub>** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

P/N GS20586 Flow, demountable cell with **ZnSe** windows, with choice of pathlength from 0.006, 0.012, 0.025, 0.05, 0.10, 0.20, 0.5 or 1.00mm.

### **Legend for “Bubble” Part Numbers with Figures**

- (1) - Front plate.
- (2) - Top gasket.
- (3) - Top window.
- (4) - Spacer.
- (5) - Lower window.
- (6) - Body.
- (7) - M3 x 12mm cap head bolt.
- (8) - “Belville” spring washer.
- (9) - Rear gasket/packing spacer.
- (10) - M3 x 6mm filling cap head bolt.
- (11) - PTFE sealing washer.
- (12) - Luer fitting.
- (13) - Thermocouple well hole.
- (14) - 1/16” O.D. stainless steel flow tube.
- (15) - Swagelok® 1/16” O.D. tubing connection union.
- (16) - Swagelok® 1/16” O.D. tubing connector.
- (17) - Flushing tube

[illegible]

# 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  
Unit 12, Science & Innovation Centre  
Halo Business Park  
Orpington  
Kent BR5 3FQ  
Tel:+44 (0) 1689 873134  
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.**

Unit 12, Science & Innovation Centre  
Halo Business Park  
Orpington  
Kent BR5 3FQ  
Tel: +44 (0) 1689 873134  
Registered No. 1008689 England