Applications Note

Insight on Color **Vol. 6, No. 6**

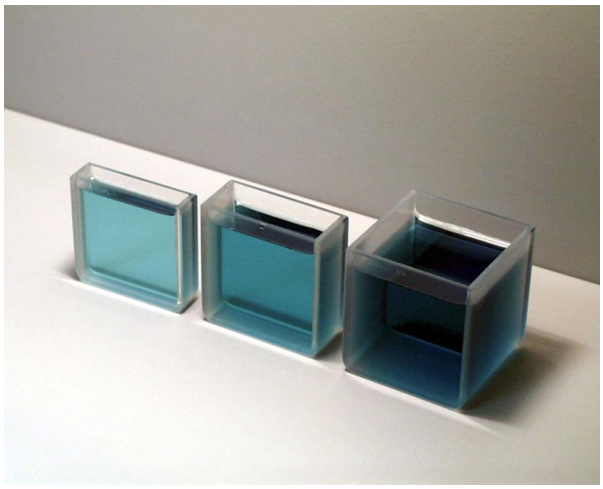
Transmission Cells

There are several types of transmission cells available for containing samples while measuring the color of transparent liquids using HunterLab sphere instruments.

- HunterLab Glass Cells – rectangular, multiple path lengths, open top and capped, no compromise in performance
- Molded Glass Cells – rectangular, rugged, best for hot solutions, suitable for heating
- Plastic Cells – 20-mm Path Length, rectangular, come with caps, disposable
- Plastic Cells – 10-mm Path Length, rectangular, open top, disposable
- HunterLab Glass Flow Through Cells - multiple path lengths, for automatic operation
- HunterLab Small Volume Glass Cells – 10-mm path length, 5 mL volume of sample
- Round Glass Vials – 24-mm path length, rugged, suitable for heating, disposable
- Analytical and Semi-Micro Cells – 10-mm and 20-mm path lengths, glass or disposable plastic, open or capped, very small sample volume needed.

HunterLab Glass Cells – Open Top and Capped

The best measurement performance is achieved when HunterLab glass transmission cells are used, as they are custom manufactured to HunterLab's specifications. Each cell is made of optical quality glass and is a three-piece construct that is first fused glass-to-glass, then annealed. Solvents will not affect these cells, as the three components are fused together at the edges, not glued. They have two flat windows and a U-shaped spacer that is abraded to minimize internal reflectance. HunterLab Quality Assurance monitors the path length, dimensions, and flatness of these cells. For critical measurements, these glass cells are recommended.



Open Top HunterLab Glass Cells

Capped Glass Cell

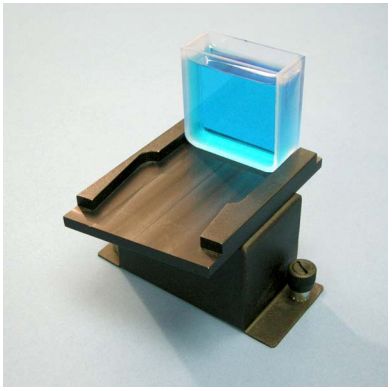
To purchase HunterLab glass cells, contact:

Order Processing Department
Hunter Associates Laboratory, Inc.
TEL: (703) 471-6870
FAX: (703) 471-4237
NET: www.hunterlab.com

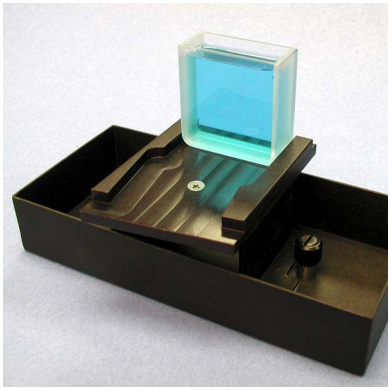
Specifications for the HunterLab glass cells are as follows:

HunterLab Catalog Number	Path Length (mm)	Cell Dimensions (Width x Height x Depth in mm)	Approximate Sample Volume Needed (mL)
13-8573-40 (open top)	10	55 x 57 x 10	20
04-4592-00 (open top)	20	55 x 57 x 20	40
B04-1003-801 (open top)	33	55 x 57 x 33	70
13-8573-20 (open top)	50	55 x 57 x 50	100
D12-1011-893 (capped)	10	55 x 57 x 10	20
D12-1011-890 (capped)	20	55 x 57 x 20	40
D12-1011-891 (capped)	33	55 x 57 x 33	70
D12-1011-892 (capped)	50	55 x 57 x 50	100

All HunterLab open top and capped glass cells will fit on the **C02-1005-481 Transmission Cell Holder** or **D02-1011-568 Transmission Spill Tray and Cell Holder** in all HunterLab sphere instruments.



C02-1005-481 Transmission Cell Holder



D02-1011-568 Transmission Spill Tray and Cell Holder

FAQ: "Can these cells be heated?"

These cells, with sample contents, can be heated to a temperature of 275°C without injury provided the heating method is even and gradual (not directional heating like a hot plate). An air-circulating heater and gradual gradient heating are recommended at temperatures near the limit of 275°. To avoid condensation, liquid samples should be heated to those temperatures in the cell or else the cell should be preheated before adding the hot sample.

Molded Glass Cells for Hot Solutions

Unlike the three-piece construction of HunterLab cells, these Pyrex glass cells are produced by a one-step tubular injection molding operation on a stainless steel (Class A) mandrel. The molded construction makes them more robust for holding hot solutions. Another application is the heating of crystalline powders in these cells to a liquid form. Then the cell is transferred to a transmission holder for measurement.

Molded Glass Cell

These molded glass cells are:

- Physically rugged for the measurement of hot solutions due to their molded construction.
- Rectangular in shape with standard path lengths.

- All molded cells will fit on the **C02-1005-481 Transmission Cell Holder** or **D02-1011-568 Transmission Spill Tray and Cell Holder** in the transmission compartment of all HunterLab sphere instruments.
- These molded cells have performance characteristics (finish, repeatability, and reproducibility) that, while not as optimal as HunterLab glass cells, are acceptable for many applications.
- There is some thickness variation in the outside wall of these cells that can result in haze readings that are 2 haze units higher than those read using HunterLab cells. As an extra service, SGI will grind the outside faces of these cells. This will minimize the wall distortion and improve the haze measurement agreement with HunterLab transmission cells.

Cells are available from:

SGI – Scientific Glass & Instruments, Inc.
2521 Fairway Park Drive, Suite 404
Houston, TX 77001
TEL: (703) 682-1481
FAX: (713) 682-3054
NET: www.sginstr.com

SGI Stock Number	Path Length (mm)	Cell Dimensions (Width x Height x Depth in mm)	Approximate Sample Volume Needed (mL)
29260-0020	10	40 x 50 x 10	15
29260-0030	20	40 x 50 x 20	30
29260-0049	33	50 x 50 x 33	70
29260-0050	50	50 x 50 x 50	100

Disposable Plastic Cells – 20-mm Path Length

Tissue culture flasks made of clear polystyrene with screw-on caps for volatiles can serve as inexpensive transmission cells that are especially useful when measuring samples that are difficult to clean up or handle. These cells are also handy when large numbers of measurements are being made.

The performance of these cells is not as optimal as that of the HunterLab glass cells but is appropriate when the need for a disposable cell outweighs the small compromise in performance.

Tissue Culture Flask
20-mm Path Length
25 mL Sample Volume

Tissue Culture Flask
20-mm Path Length
50 mL Sample Volume

All disposable plastic cells will fit on the **C02-1005-481 Transmission Cell Holder** or **D02-1011-568 Transmission Spill Tray and Cell Holder** in the transmission compartment of all HunterLab sphere instruments.

Tissue Culture Flasks are available from:

Fisher Scientific
TEL: (800) 766-7000
NET: http://www.fishersci.com

Fisher Scientific Catalog Number	Path Length (mm)	OD Dimensions of Measurement Face (Width x Height x Depth in mm)	Approximate Sample Volume Needed (mL)
08-772-1E BD Biosciences 353018 T-12.5-cm2 Tissue Culture Flasks	20	35 x 35 x 25	25
10-126-1B BD Biosciences 353013 T-25-cm2 Tissue Culture Flasks	20	70 x 40 x 25	50

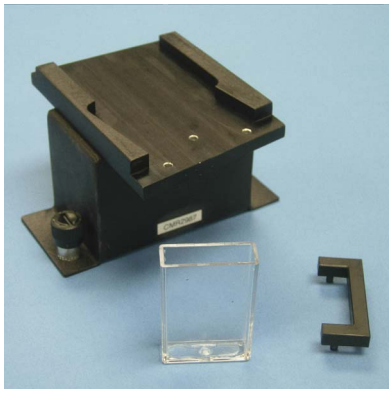
FAQ: "What is the difference between the 25 mL and 50 mL tissue culture flasks besides volume of sample used?"

Both flasks have the same path length and cover the port. However, you have to be more careful in the placement of the smaller 25 mL flask to make sure the flask is centered and flush at the port. With the larger 50 mL flask, cell placement isn't as critical and can be done more quickly.

Disposable Plastic Cells – 10-mm Path Length

Acrylic cells with a 10-mm path length are also available and are sufficiently cost-effective as to be disposable.

10-mm Acrylic Cell on standard C02-1005-481 Transmission Cell Holder measuring transparent liquids in TTRAN mode



CMR2987 Modified Transmission Cell Holder for 10-mm Acrylic Cells has an L-bracket clip to more precisely position cell at TTRAN port

- These cells are made of clear acrylic and are open at the top.
- They will fit in the transmission compartment of all HunterLab sphere instruments using a standard **C02-1005-481 Transmission Cell Holder** or **D02-1011-568 Transmission Spill Tray and Cell Holder**, but a better option is the **CMR2987 Modified Transmission Cell Holder for 10-mm Acrylic Cells**. This is the standard transmission cell holder with an L-bracket added to more precisely position these 10-mm acrylic cells at the measurement port.

Order these cells from:

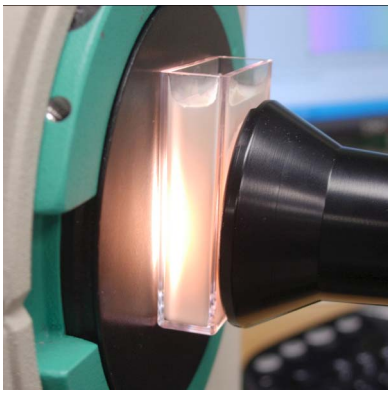
Lumelite Plastics
85 Charles Colman Blvd.
Pawling, NY USA 12564
TEL: (845) 855-1201
FAX: (845) 855-5219
NET: www.lumelite.com

Lumelite Part Number	Path Length (mm)	OD Dimensions of Measurement Face (Width x Height x Depth in mm)	Approximate Sample Volume Needed (mL)
24022642	10	32.5 x 45 x 12.5	20

FAQ: "Can these cells be used to measure opaque liquids or powders in reflectance?"

Yes, the 10-mm plastic cells will cover the reflectance port using the sample clamp to position the cell and keep the cell flush at the port while maintaining a constant surround using the white ceramic backing if the sample is not fully opaque.

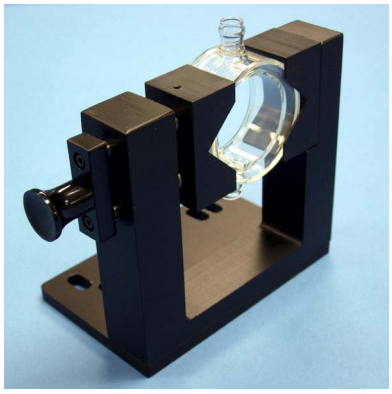
It is recommended that you standardize in RSEX LAV (Reflectance Specular Excluded, Large Area of View) mode to negate the specular reflectance off the plastic window from the measurement. The absorbance of the plastic window will still be part of the measurement, but it is a constant and less than 1% absorbance.



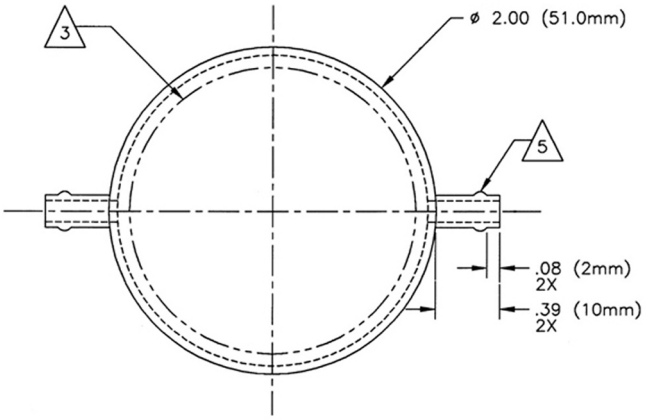
10-mm Acrylic Cell used to measure color of near-opaque liquid in RSEX reflectance

HunterLab Glass Flow Through Cells

A flow through cell can be handy for continuous sampling or ease of measurement with a transparent liquid product.



Flow Cell in D02-1009-960 Flow Through Cell Holder



Flow Cell

To purchase HunterLab glass cells, contact:

Order Processing Department
Hunter Associates Laboratory, Inc.
TEL: (703) 471-6870
FAX: (703) 471-4237
NET: www.hunterlab.com

Specifications for the HunterLab glass flow through cells are as follows:

HunterLab Catalog Number	Path Length (mm)	Diameter of Measurement Face (mm)	Port OD/ID (mm)	Approximate Sample Volume Needed (mL)
CMR2885	2	51	7/9	15
C04-1001-958	10	51	7/9	20
C04-1001-959	20	51	7/9	35

HunterLab Catalog Number	Path Length (mm)	Diameter of Measurement Face (mm)	Port OD/ID (mm)	Approximate Sample Volume Needed (mL)
CMR2331	33	51	7/9	65
C04-1001-960	50	51	7/9	90

- All flow cells will fit in the transmission compartment of all HunterLab sphere instruments using the **D02-1009-960 Flow Through Cell Holder.**
- The construction of the cells is clear annealed borosilicate, which can be heated (including the sample) in a water bath to 100 degrees Centigrade with no difficulty.
- The flow cells are aligned vertically in the holder and fed from the bottom to minimize air bubbles.
- The inlet and outlet ports are 7-mm ID and 9-mm OD to permit a high flow rate with port continuity at all path lengths so that the same tubing and pump can be used.

You will need to purchase tubing and a peristaltic pump appropriate for your needs from non-HunterLab sources. Tygon tubing is clear, robust, and has good product life as peristaltic tubing. Peristaltic pumps such as the MasterFlex line are acceptable. Both products are available from Cole Parmer (www.coleparmer.com).

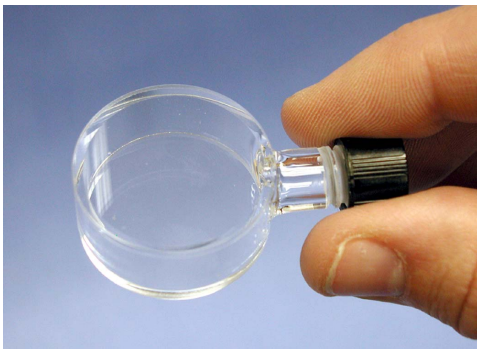
Flow Cell Operation

A length of tubing is attached to the 9-mm OD of each of the two cell ports. At the other end of each length of tubing, it is good idea to attach a piece of glass tubing to be lowered into a beaker of sample liquid. Place the flow cell in the D02-1009-960 holder. Turn the peristaltic pump on. The pump rubs on the outside of the tubing, creating an internal vacuum within the tubing that sucks liquid through and into the cell. The cell is oriented in the D02-1009-960 Flow Through Cell Holder with the outlet port at the top. Air is automatically forced out of the cell as the liquid comes in. As soon as the flow cycle is complete, a measurement can be taken. To flush the system, turn off the pump, place the glass ends of the tubing into a beaker of water/solvent and cycle until clean.

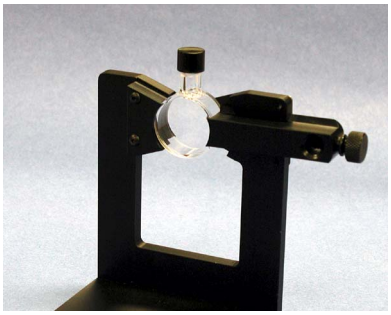
FAQ: "What is the advantage of using the 2-mm flow cell?"

Some liquid samples are so highly absorbing or translucent such that little light from the instrument's lamp can get through in transmission. By using a very thin 2-mm path length with these samples, it is possible to differentiate lot differences in color that would not be possible with a regular path length cell.

HunterLab Small Volume Cell – 10-mm Path Length



A13-1011-613 Small Volume (4 mL) Transmission Cell with 10-mm Path Length



A13-1011-613 Small Volume Transmission Cell in D02-1011-886 Transmission Holder

Specifications for the HunterLab round glass cells are as follows:

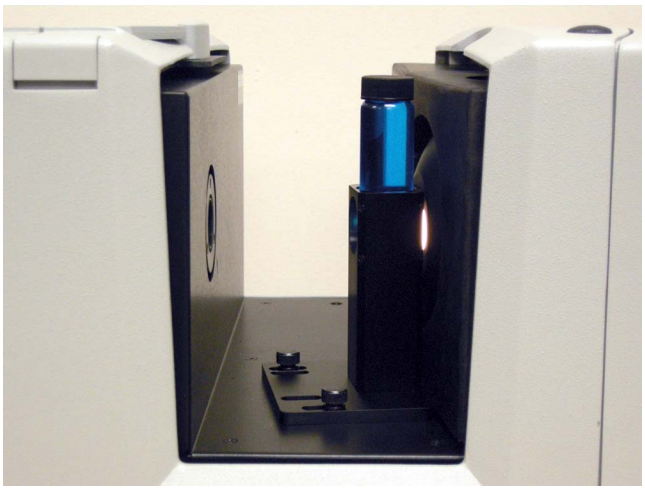
HunterLab Catalog Number	Path Length (mm)	Diameter of Measurement Face (mm)	Port OD/ID (mm)	Approximate Sample Volume Needed (mL)
A13-1011-613	10	25	12/8	4

- **HunterLab Part # A13-1011-613** is a practical small volume transmission cell for transmission color measurements that was developed to measure the color of small volumes of very expensive development drugs in the pharmaceutical industry. It is a small, optically clear, manual loading, 10-mm path length round cell with a screw top.
- A13-1011-613 includes both an inject-a-cell top (that allows you to use a needle to load the cell through an injectable silicone membrane in the cell top) and second solid propylene top (good for volatile samples).
- A **special D02-1011-886 Transmission Holder** is needed to hold these small volume round cells at either the TTRAN or RTRAN port.
- This 10-mm path length round glass cell has an OD of 28-mm and an ID of 25-mm which just covers the transmission port. If you fill the cell to the top, 5-mL of sample is needed. If you fill the cell to the bottom of the screw top above the viewed sample area, the volume required is 4-mL of sample. By comparison, the standard rectangular HunterLab 10-mm cell uses 20-mL of sample.
- The throat has a 12-mm OD and an 8-mm ID, allowing the cell to be loaded with a pipette or needle.
- The 10-mm path length allows you to standardize to top-of-scale (100% transmission) using the cell with distilled water as a blank, and yet still have sufficient path length to differentiate small amounts of chromofores in near-clear liquids, as well as measure the APHA/PtCo/Hazen color scale if desired.

- Haze measurements in TTRAN LAV mode are also possible.

Disposable Round Glass Vials – 24-mm Path Length

These round vials have the advantage of being made of borosilicate glass appropriate for corrosives. They come with caps to handle volatiles and are sufficiently cost effective to be disposable or recyclable.



40-mL 24-mm Path Length Glass Vial in D02-1011-550 Transmission Holder at TTRAN Port

HunterLab D02-1011-550 Transmission Holder for 27 - 30-mm Vials

- The **HunterLab D02-1011-550 Transmission Holder for 27 - 30-mm Vials** positions the curved surface of the round glass vial consistently for measurement at the TTRAN port.
- The D02-1011-550 holder accepts all 20 mL, 40 mL and 60 mL round glass vials and fits in all HunterLab sphere instruments. There are 4 user-adjustable screws in the holder that can be employed to ensure that the vial does not wiggle in the holder.
- The 40-mL (1 1/3 oz) borosilicate glass threaded vial with a 27, 28 or 29-mm OD and 61-mm height is **recommended for general use** as a round disposable glass transmission cell on HunterLab instruments.
- The 20-mL (2/3 oz) version is **recommended for small sample volumes**. These vials will fit in the transmission compartment of the ColorQuest XE, ColorQuest XT, UltraScan XE, UltraScan PRO, or UltraScan VIS with the door closed.
- There is also a 60-mL high vial of the same diameter that fits above the door for exterior venting or external loading if required. The 60-mL size is **recommended for measuring the color of hot solutions**, as the extra height allows the tube to be more easily grasped by a set of tongs.
- In all cases, the internal diameter is 24-mm, defining the sample path length.
- These round tubes work well when the material must be centrifuged for mixing or separating, or if the materials need to be heated. The polypropylene caps and molded borosilicate glass can be autoclaved up to their melting points (450 degrees C), provided the heating and cooling is done slowly at a rate of 50 degrees per hour or less. There is the potential for cracking if the temperature is raised/lowered to high levels at rapid rates. For lower temperatures (< 150 degrees C), heating and cooling should be no problem.

Round glass vials can be ordered from:

Qorpak
Corporate One West
1195 Washington Pike
Bridgeville, PA USA 15017-2808
TEL: 800-922-7558
TEL: 412-257-3100
FAX: 412-257-3001
NET: www.qorpak.com

Qorpak Catalog Number	Path Length (mm)	Round Vial OD/ID/Height (mm)	Approximate Cell Volume Needed (mL)
2V20QEDC	24	27.4 OD 24 ID with 57 height	20
2V40QEDC	24	27.4 OD 24 ID with 95 height	40
GLC07880	24	30 OD 24 ID with 140 height	60

Vial Options include**:**

- Polypropylene caps in solid polypropylene and injectable silicone septa are available assembled with the vials or separate.
- A variety of internal cap liners can also be chosen, including metal, foamed polyethylene, polyethylene, vinyl and Teflon (minimal chemical reaction) disc liners.
- Individual barcode labels can be affixed for sample identification.
- There are a variety of cleaning procedures (vacuum ionization, particulate washing, and gamma sterilization) that can be done to ensure that there are no residual particulates (dirt, dust, carton lint, fine glass particulates, bacteria) or film (bottle release agents, aerosols, oil) on the glass surface. The most cost-effective is to order vials that are cleaned but do not have a certificate enclosed with each box. This provides an EPA-cleaning without the additional cost of certification.
- Some suppliers also have the same products available in HDPE: high-density polyethylene.
- These vials usually come shrink-wrapped with 72 or 144 in a case.

FAQ: "Can clear vials from other sources be used?"

Yes, as long as the OD is 27-mm to 30-mm. For the best inter-instrument agreement at multiple sites, use the same brand of vials.

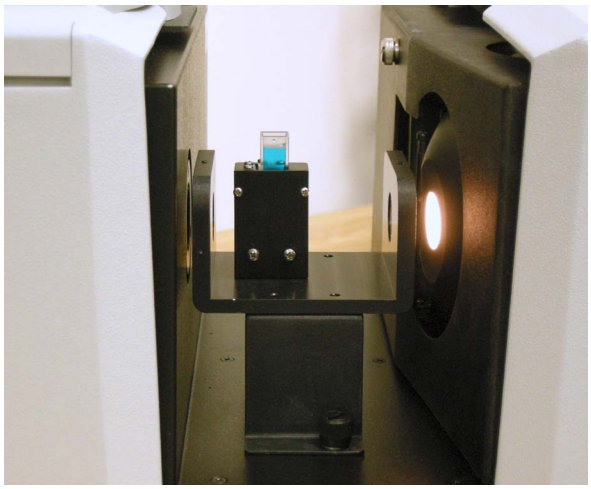
FAQ: "Do we standardize in TTRAN LAV (Large Area of View) or SAV (Small Area of View) mode for vial transmission measurements?"

You can standardize in either mode, with LAV preferred for better area averaging of the sample color.

Analytical and Semi-micro Cells for Very Small Volumes

Glass and plastic analytical and semi-micro cells can be used for transmission color measurement in HunterLab sphere instruments when the available sample volume is very small.

Analytical and semi-micro cells come in plastic or glass



Analytical 10-mm Cell in L02-1012-202 Semi-Micro Cell Holder and Optical Assembly in USVis Transmission Compartment

HunterLab L02-1012-202 Semi-Micro Cell Holder and Optical Assembly

The key advantage of these cells is that they allow color measurement of very small sample volumes at a 10-mm path length.

The **L02-1012-202 Semi-Micro Cell Holder and Optical Assembly** is a cell holder with two optical elements built into the holder. The front optic reduces the light source's beam size from 17.4-mm LAV at TTRAN position to 3-mm that then passes through the cell area for sample measurement. The sample beam is then expanded by the back optic to 17-mm, collected by the regular lens and imaged onto the detector.

Sources for analytical and semi-micro cells:

NSG Precision Cells, Inc.
Farmingdale, NY USA 11735
TEL: 631-249-7474
FAX: 631-249-8575
NET: www.nsgpci.com

NSG Catalog Number	Path Length (mm)	OD Dimensions of Measurement Face (Width x Height x Depth in mm)	Approximate Cell Volume Needed (mL)
Type 1P - Plastic Analytical Cells	10	12.5 x 45 x 12.5	3.5
Type 9P - Plastic Semi-Micro Cell	10	12.5 x 45 x 12.5	1.4 to top of cell 0.4 to cover viewed area
Type 1 -Glass Analytical Cells	10	12.5 x 45 x 12.5	3.5
Type9 - Glass Semi-Micro Cell	10	12.5 x 45 x 12.5	1.4 to top of cell 0.4 to cover viewed area

There is an additional cell attachment for the L02-1012-202 Semi-Micro Cell Holder that will hold 20-mm path length cells.

Catalog Number	Path Length (mm)	OD Dimensions of Measurement Face (Width x Height x Depth in mm)	Approximate Cell Volume Needed (mL)
Type 1 - Glass Analytical Cells	20	12.5 x 45 x 22.5	7

Fisher Scientific
TEL: (800) 766-7000
NET: http://www.fishersci.com

Fisher Scientific Catalog Number	Path Length (mm)	OD Dimensions of Measurement Face (Width x Height x Depth in mm)	Approximate Cell Volume Needed (mL)
14-385-985 or 14-385-996 Fisherbrand Plastic Analytical Cuvettes or Cells	10	12.5 x 45 x 12.5	3.5
13-385-938 or 14-385-942 Fisherbrand Plastic Analytical Cuvettes or Cells	10	12.5 x 45 x 12.5	1.5 to top of cell 0.4 to cover viewed area
NC9274003 or NC9469798 Glass Analytical Cuvettes or Cells	10	12.5 x 45 x 12.5	3.5
NC9056438 Glass Semi-Micro Cuvettes or Cells	10	12.5 x 45 x 12.5	1.4 to top of cell 0.4 to cover viewed area

FAQ: "I have just over 4-mL of sample for each measurement. Should I use the regular analytical cells or the micro-cell?"

Use the larger analytical cell. When you go to the smaller micro-cell, little details like cell cleanliness become very critical. It's best to use the largest cell for which you have sufficient sample.

For Additional Information Contact:

Technical Services Department
Hunter Associates Laboratory, Inc.
11491 Sunset Hills Road
Reston, Virginia 20190
Telephone: 703-471-6870
FAX: 703-471-4237
www.hunterlab.com