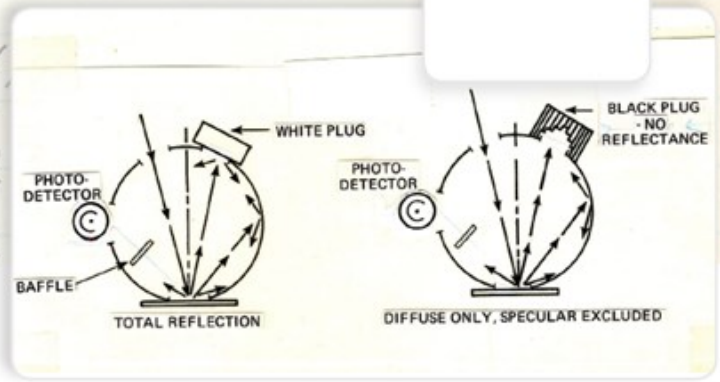
Applications Note

AN 1091



Transmittance Cells

The best measurement performance is achieved when HunterLab glass transmittance cells are used, as they are custom manufactured to HunterLab's specifications.

Abstract

There are several types of transmittance cells for measuring transparent liquids. From glass to plastic, flow through to heated cells and disposable versions, there are cells available to measure the color of transparent samples. 10mm and 20mm pathlengths for very small samples can also be accommodated in semi-micro cells and analytical cells.

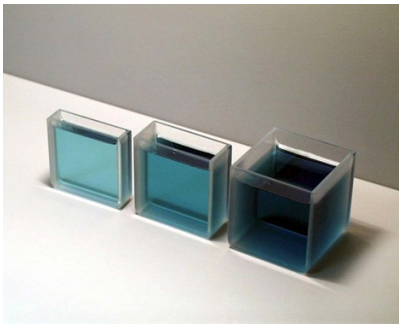
The world's true measure of color
HunterLab

There are several types of transmittance 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

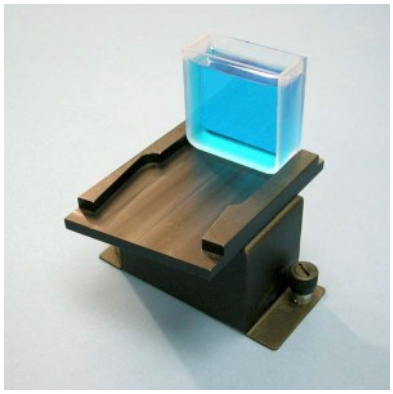
The best measurement performance is achieved when HunterLab glass transmittance cells are used, as they are custom manufactured to HunterLab's specifications. Each cell is made of optical quality glass and is a three-piece construct that is first fused glass-to-glass, then annealed. Solvents will not 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.



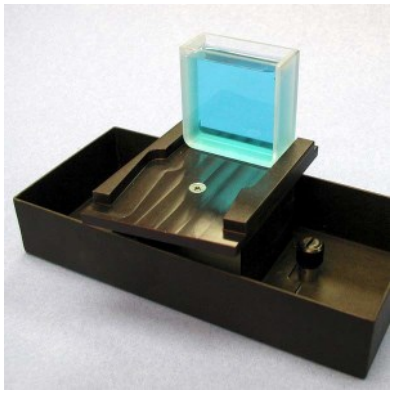
Open Topped Glass Cell

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

Capped Glass Cell



C02-1005-481 Transmittance Cell Holder



D02-1011-568 Spill Tray & Cell Holder

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

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 transmittance 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 Transmittance Cell Holder** or **D02-1011-568 Transmittance Spill Tray and Cell Holder** in the transmittance 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, SGT will grind the outside faces of these cells. This will minimize the wall distortion and improve the haze measurement agreement with HunterLab transmittance 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 transmittance 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.

Tissue Culture Flash 20mm Path-length, 25mL Volume

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.

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

Tissue Culture Flasks are available from:

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

Tissue Culture Flash 20mm Path-length, 5mL Sample Volume

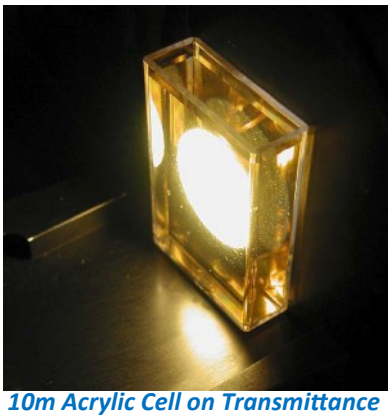
Fisher Scientific Catalog Number	Path Length (mm)	OD Dimensions of Face (W x H x D in mm)	Approximate Sample Volume Needed (mL)
08-772-1E BD Biosciences 353018 T-12.5-cm^2 Tissue Culture Flasks	20	35 X 35 X 25	25
10-126-1B BD Biosciences 353013 T-25-cm^2 Tissue Culture Flasks	20	70 X 40 X 25	50

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 25mL flask to make sure the flask is centered and flush at the port. With the larger 50mL flask, cell placement isn't as critical and can be done more quickly.

Disposable Plastic Cells - 10-mm Pathlength

Acrylic cells with a 10mm path length are also available and are sufficiently cost-effective as to be disposable. These cells are made of clear acrylic and are open at the top.

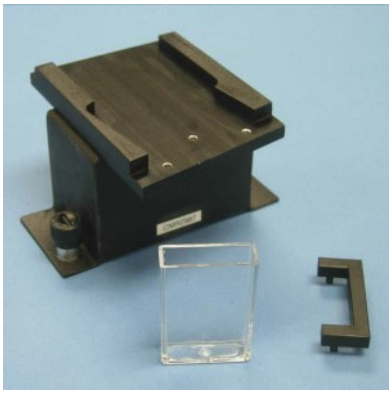


10m Acrylic Cell on Transmittance Cell Holder

They will fit in the transmittance compartment of all HunterLab sphere instruments using a standard **C02-1005-481 Transmittance Cell Holder** or **D02-1011-568 Transmittance Spill Tray and Cell Holder**, but a better option is the **CMR2987 Modified Transmittance Cell Holder for 10-mm Acrylic Cells**. This is the standard transmittance 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, www.lumelite.com



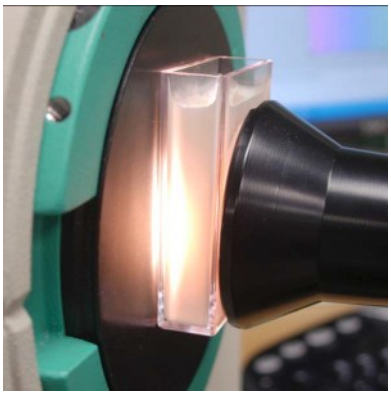
CMR 2987 Modified Transmittance Cell Holder for 10mm Cells

Lumelite Part	Pathlength	OD of Face	Approx. Sample
24022642	10	32.5x45x12.5	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.

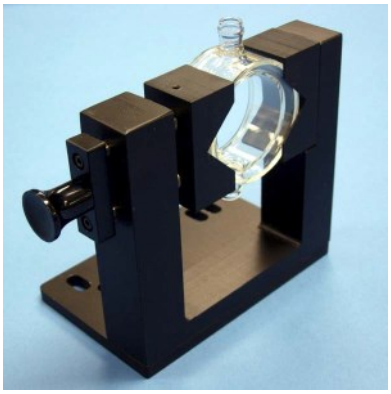
It is recommended that you standardize in RSEX LAV (Reflectance Specular Excluded, Large Area of View) mode to negate the specular reflectance off the plastic window from the measurement. The absorbance of the plastic window will still be part of the measurement, but it is a constant and less than 1%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



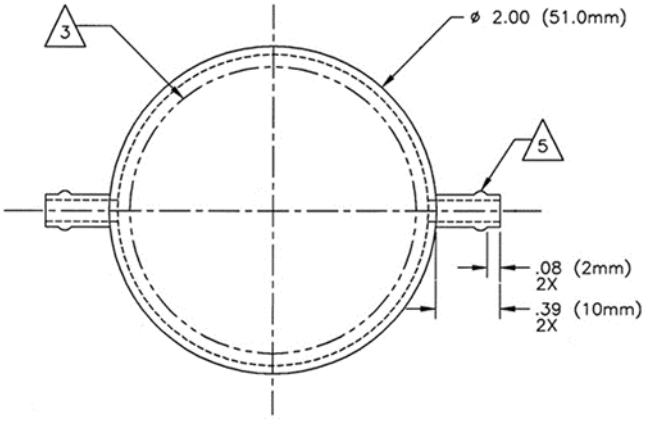
10mm Acrylic Cell for Near-Opaque Liquids in RSEX

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 Flow Through Cell Holder (D02-1009-960



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)	Approx. 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
CMR-2331	33	51	7/9	65
C04-1001-960	50	51	7/9	90

- All flow cells will fit in the transmittance 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 flow cells are aligned vertically in the holder and fed from the bottom to minimize air bubbles.

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 transmittance. 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.

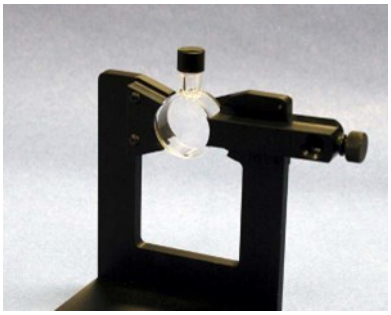
Hunterlab Small Volume Cell - 10-mm Path length

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 transmittance cell for transmittance color measurements that was developed to measure the color of small volumes of very expensive development drugs in the pharmaceutical industry. Tt 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 Transmittance 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 TD of 25-mm which just covers the transmittance port. If you fill the cell to the top, 5-mL of sample is needed. Tf 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.

Small Volume Transmittance Cell with 10mm Pathlength



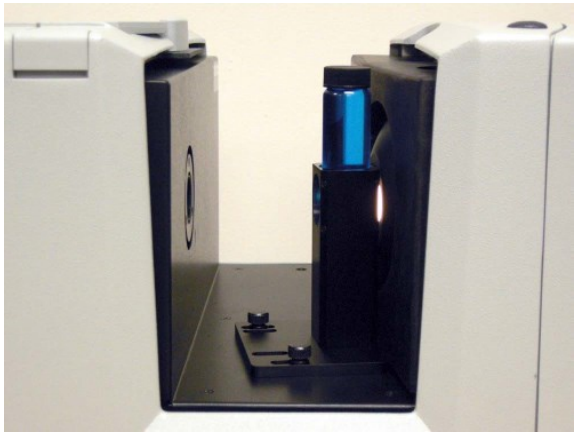
Transmittance Holder D02-1011-886

- The throat has a 12-mm OD and an 8-mm TD, 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% transmittance) using the cell with distilled water as a blank, and yet still have sufficient path length to differentiate small amounts of chromophores in near-clear liquids, as well as measure the APHA/PtCo/Hazen color scale if desired.
- Haze measurement 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.

- The **HunterLab D02-1011-550 Transmittance 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.



Transmittance Holder at TTRAN Port with 24mm Pathlength Glass Vial

- 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 transmittance cell on HunterLab instruments.
- The 20-mL (2/3 oz) version is **recommended for small sample volumes**. These vials will fit in the transmittance compartment of the Vista, 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.

Transmittance Holder for 27-30mm Vials.

- Tn 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 TD with 57 height	20
2V40QEDC	24	27.4 OD 24 TD with 95 height	40
GLC07880	24	30 OD 24 TD 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 transmittance 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 transmittance color measurement in HunterLab sphere instruments when the available sample volume is very small.

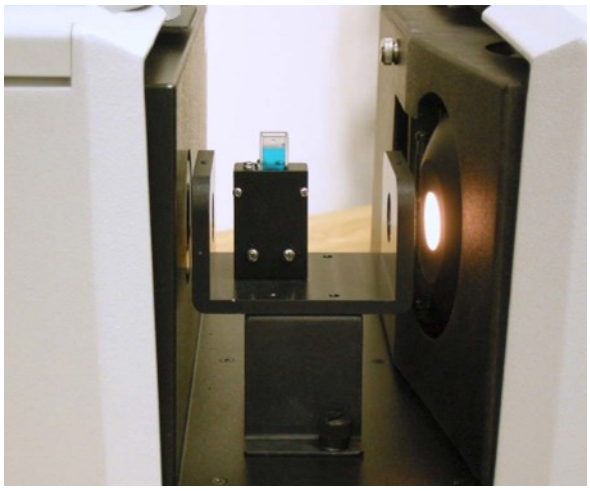
The key advantage of these cells is that they allow color measurement of very small sample volumes at a 10-mm path length.

Analytical and Semi-Micro Cells

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, www.nsgpci.com



Semi Micro Cell Holder with Analytical 10mm Cell in UltraScan VIS Transmittance Compartment

Semi-Micro Cell Holder L02 -1012-202

NSG Catalog Number	Path Length (mm)	OD 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
Type 1—Glass Analytical Cell	20	12.5 X 45 X 12.5	7

Fisher Scientific, TEL: (800) 766-7000, 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. Tt's best to use the largest cell for which you have sufficient sample.

About HunterLab

HunterLab is the technology leader in color measurement solutions, providing instruments, software, knowledge and service to a wide variety of industries.
With over 5 decades of experience in more than 65 countries, HunterLab applies our leading edge technology to your products helping you measure and communicate color simply and effectively.

 11/2023

The world's true measure of color
HunterLab