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Reference Cells

Gas Reference Cells Overview (Page 1 of 2)



Applications:

- Tunable Laser Calibration
- Stabilized Frequency Source
- OSA Calibration
- Gas Analyzer Calibration
- Calibration of Wavelength Meter
- Frequency Standards

Gas reference cells, hereafter referred to as reference cells, are often used in applications where the wavelength of light needs to be accurately determined. Although spectrometers and optical spectrum analyzers are built specifically for this purpose, both need to be accurately calibrated in order to yield accurate absolute wavelength measurements. A reference cell consists of a cylindrical container (cell) containing a high purity molecular compound or atomic element. During the manufacturing of the reference cell, the temperature and pressure inside the cell are precisely regulated since these factors affect the reference cell performance.

A reference cell can serve as an absolute wavelength calibration source because the substance inside the reference cell will only absorb light at wavelengths that correspond to the allowed energy level transitions. For the materials offered in the reference cells sold by Thorlabs, the

absorption lines are well known. The absolute wavelength of the absorption lines can be found in peer reviewed journals and in some cases online at www.nist.gov. In order to reproduce the absorption lines reported by these sources, the temperature and contents of the reference cell need to be identical to the cell used in the reported measurement since changes in temperature, pressure, and material can cause shifts and/or broadening of the absorption lines.

Reference Cell Contents

The alkali atoms are located in the first column of the periodic table. Thorlabs offers alkali reference cells that contain sodium, potassium, rubidium, or cesium. In alkali atom reference cells, the bulk of the material in the cell will be coalesced in a solid or liquid form on the cell walls. However, since the cell was sealed under vacuum conditions, alkali vapor will be present. The atomic vapor will absorb light with wavelengths corresponding to the allowed transitions between the energy levels of the atoms. When the reference cell is at room temperature, the light absorbed will be principally due to transitions between the ground state and excited electronic states of the atom. A reference cell that contains an alkali atom source is sometimes referred to as a vapor reference cell.

Additional vapor reference cells offered by Thorlabs include cells with water or iodine as the source material. The iodine vapor forms the diatomic molecule I_2 . Water and iodine absorb light corresponding to transitions between rotational and/or vibrational energy levels in the molecule.

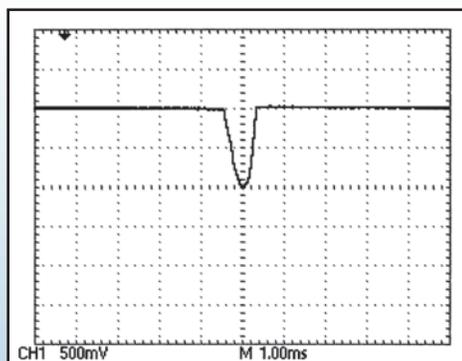
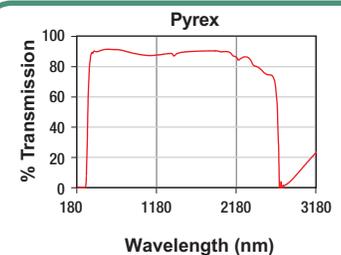
In addition to vapor reference cells, cells that contain molecules that exist in the gaseous state at room temperature are available. When these reference cells are loaded with the molecular gas and sealed, the pressure and temperature are precisely

controlled so that it is possible to reproduce the conditions, and as a result, the location of the absorption lines reported in literature. The molecular gas reference cells sold by Thorlabs include acetylene, hydrogen cyanide, carbon monoxide, carbon dioxide, nitrogen dioxide, methane, ethane, and ethylene. Each gas has a unique set of absorption lines corresponding to allowed transitions between rotational and vibrational energy levels.

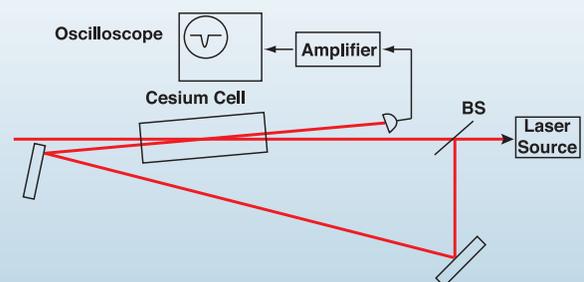
Due to the number of absorption lines in the NIR region of the electromagnetic spectrum, molecular gas reference cells make excellent calibration sources for light sources and test equipment used in the Telecom industry. The National Institute of Standards and Technology (NIST) has created wavelength reference standards for the Telecom industry based on Standard Reference Materials (SRM): 2515 (carbon monoxide), 2517a (acetylene), and 2519 (hydrogen cyanide).

Reference Cell Containers

Thorlabs' reference cells are made from either Pyrex or quartz. As shown in the plot below, Pyrex is an inexpensive material with good optical transmission characteristics (i.e., transmission > 92%) between 350 nm and 2400 nm. It is also less susceptible to breaking or chipping than quartz. Due to its chemical stability, this material is suitable for holding K, Na, Cs, or Rb. The standard sized Pyrex cell measures Ø25 mm and 75 mm long.



This is a typical saturated absorption experiment using a cesium reference cell that yields a plot of the Doppler-free Cs absorption line at 852 nm.

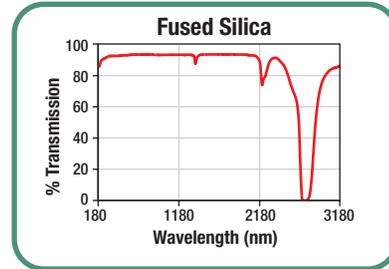


Gas Reference Cells Overview (Page 2 of 2)

Although quartz is a more expensive material than Pyrex, it offers higher transmission deeper into the UV spectral range (see the transmission plot at the right) and a lower coefficient of thermal expansion. Hence, it is more resilient to thermal shock. The cell is constructed from a quartz cylindrical tube with a UV fused silica (synthetic fused quartz) window on each end. Each window has a 2° wedge and is mounted at an angle with respect to the length of the cell to minimize saturation and interference effects due to surface reflections. The

angled surfaces prevent the surface reflection from retracing the same optical path as the incident light. In addition, the UV grade fused silica windows have an optical flatness of $\lambda/4$ for minimal wavefront distortion of the light passing through the cell.

The thermal properties as well as the welded construction of the quartz cell make it suitable for high-temperature applications (up to 850 °C). Except for potassium and sodium, all other materials are available in a quartz reference cell.



Pyrex Reference Cells



Specifications

- **Window Material:** Schott Borofloat® Glass
- **Cell Diameter:** 25 mm
- **Fill Stem:** <10 mm
- **Window Angle:** 0°
- **Window Type:** Flat
- **Window Thickness:** 1.6 mm
- **Fill Pressure Temperature:** 25 °C

The Pyrex reference cells offered by Thorlabs have optical quality Schott Borofloat® windows and are tested to ensure that the transmission of off-resonant light through the reference cell exceeds 84%. The transmission loss is primarily due to surface reflections from the windows. The content of the reference cell is also tested by measuring the absorption spectra of a well known transition using a tunable diode laser. The following transitions are used for each reference cell: 589 nm for sodium, 764 nm for potassium, 780 nm for rubidium, and 852 nm for cesium.

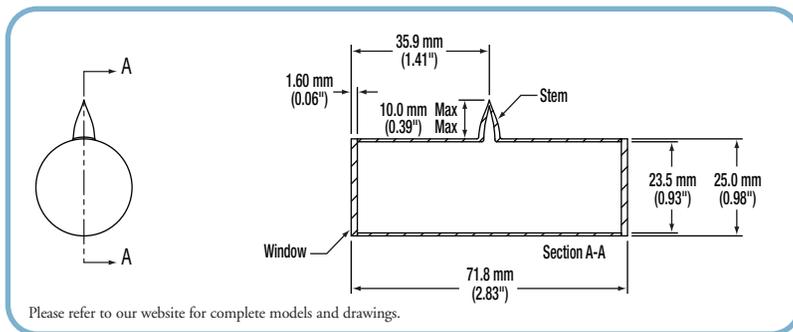
The standard reference cells are evacuated before the fill material is added, and the cell is sealed so that the fill material is the only material inside the cell. However, the reference cells can be ordered with the fill material and a buffer gas at a specified pressure. The noble gases, as well as nitrogen, are commonly used as buffer gases. The presence of a buffer gas will cause the central wavelength of the absorption lines to shift and the width of the absorption lines to broaden.

Have you seen our...

Integral Feedback Controller



See page 1814



Email Technical Support
techsupport@thorlabs.com
 for custom reference cells.

ITEM #	\$	£	€	RMB	PRESSURE	DESCRIPTION
CP25075-NA	\$ 465.00	£ 334.80	€ 404,55	¥ 3,706.05	>1x10 ⁻⁷ Torr	Ref. Cell, Pyrex Ø25 x 71.8 mm, Sodium (Na)
CP25075-K	\$ 465.00	£ 334.80	€ 404,55	¥ 3,706.05	>1x10 ⁻⁷ Torr	Ref. Cell, Pyrex Ø25 x 71.8 mm, Potassium (K)
CP25075-RB	\$ 465.00	£ 334.80	€ 404,55	¥ 3,706.05	>1x10 ⁻⁷ Torr	Ref. Cell, Pyrex Ø25 x 71.8 mm, Rubidium (Rb)
CP25075-CS	\$ 465.00	£ 334.80	€ 404,55	¥ 3,706.05	>1x10 ⁻⁷ Torr	Ref. Cell, Pyrex Ø25 x 71.8 mm, Cesium (Cs)