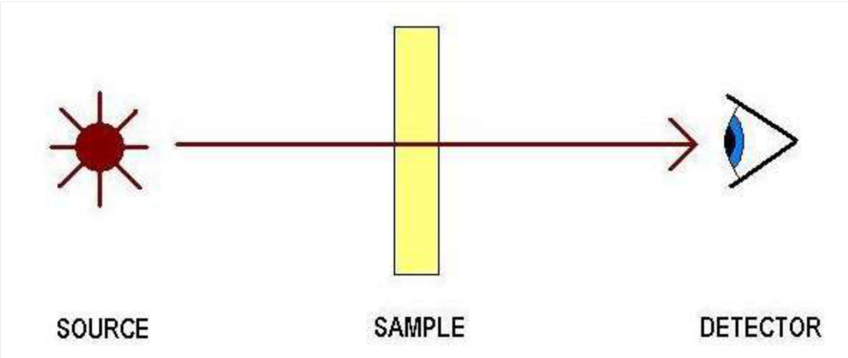
Keywords:- Transmission, Solids, Liquids, Gases.

Transmission Spectroscopy

Transmission spectroscopy is the oldest and most basic technique for analysing samples in the infrared. It can be represented by the simple schematic as shown below.



Light from a source passes through a sample to be registered by a detector. The method of analysis is based upon the absorption of the infrared beam by a sample at specific wavelengths or frequencies of light. A sample presented to the infrared beam in this configuration will produce an infrared spectrum unique to the sample itself. In this way, infrared spectroscopy is used as a **qualitative** measurement of a sample.

The extent of an absorption (**A**) of the infrared beam at a particular frequency or wavelength of light is defined by the Beer-Lambert Law.

$$A = abc$$

Where **a** is the absorptivity coefficient, **b** is the pathlength and **c** is the concentration.

Use of the Beer Lambert Law for infrared data determines how much of a sample is present and hence also provides for a **quantitative** measurement of a sample.

Solid Samples

A variety of methods exist for analysing solid samples by transmission spectroscopy. Thin polymer films can be analysed directly by use of a simple film holder. Transmission spectra of solids can also be obtained by grinding together the sample with an infrared transparent matrix, such as KBr, and pressing the resulting powder into a thin disc. A press and a 13mm die set are usually the items needed for the production of a KBr pellet.

Another method of analysing solids is to make a mull by combining (grinding) the sample with a liquid paraffin, such a Nujol. The resulting paste is placed between two circular infrared transparent windows and held in the spectrometer sample compartment using an Omni™ Cell holder.

A diamond compression cell (the DC-2) is available for transmission studies of single fibers and other micro samples.

Liquid Samples

For transmission spectroscopy, liquids are analysed as a thin film placed between two windows in a liquid cell. The type of liquid cell, window material and pathlength is determined by the sample itself and operating conditions for particular temperatures, flow and pressure. For certain volatile solutions it is recommended that a sealed type of cell is preferred to a demountable version.

Liquid samples can be analysed neat or diluted with an appropriate solvent. In order to perform quantitative analysis, the sample must be contained in a liquid cell of known pathlength. The pathlength of a liquid cell can be calculated from the fringing pattern obtained with an empty liquid cell using 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)
$\mathbf{f_1}$ = frequency at first peak (wavenumber position)
$\mathbf{f_2}$ = frequency at second peak (wavenumber position)

A guide to pathlength selection for different concentrations of solutions when analysing by infrared spectroscopy is as below:

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

Specac produces two types of liquid cell for transmission spectroscopy measurement. There are the Omni™ Cell type of liquid cells (1800 series) for room temperature and non-flow type measurements or the 20500 series types of liquid cells for static or flow and variable temperature measurements.

Gas Samples

Gases have densities which are several orders of magnitude lower than liquids and solids at standard temperature and pressure (STP). Therefore, transmission spectroscopy of gases requires analysis cells with a longer pathlength than those used for liquid or solid samples.

A typical gas cell is usually of a 10cm pathlength, but for very low concentrations of gases, Specac can provide gas cells up to 20 metres in pathlength. This pathlength is achieved in a small space by using a multi-pass cell with internal mirrors whereby the infrared beam is passed through the gas sample several times to obtain the desired pathlength.

The types of long pathlength gas cells Specac offers are found from the Cyclone™ and Tornado™ range.

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