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Applications Note
AN1005

Optical Filters for NDIR Gas Detection

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The choice of optical filter is critical to the operation of the NDIR system and it should be selected according to the gas to be measured and its absorption spectra. For example, CO_2 has a strong absorption peak around 4.26 µm and many hydrocarbon compounds have absorption peaks over the 3.3 - 3.5 µm waveband. The detection wavelengths for a number of gases are summarised in

Table 1. Extra consideration when choosing the detection wavelengths should be given when multiple gases are present, as overlapping infrared absorption spectra can cause cross-interference. For instance, CO_2 and H_2O often initiate cross sensitivity in the infrared spectrum. For fixed wavelength NDIR detection systems, the optical filter is normally integrated into the package of the detector.

Gas	**Detection Wavelengths (µm)**
CH_4	3.2 - 3.5, 7.7
SO_2	4.1
CO	4.64
CO_2	4.26 - 4.3 , 13.6
COS	5
NO	5.2 - 5.3, 5.5
NO_2	5.5, 6.4
H_2S	7.5
NH_3	1.5, 10, 10.74
SF_6	10.8
O_3	9, 9.6
H_2O	6.4

Table 1: Gas absorption wavelengths.

Optical Bandpass Filter Characteristics

Bandpass filters are designed to isolate a region of the optical spectrum which is accomplished using a complex process of constructive and destructive interference. There are a number of parameters which define the characteristics of an optical bandpass filter which are illustrated in Figure 1.

- Center Wavelength (CWL)—the wavelength at the center of the passband.
- Full Width at Half Maximum (FWHM)—the bandwidth at 50% of the maximum transmission.
- Peak Transmission (T_{peak})—the wavelength of maximum transmission.
- The blocking range—the spectral region in which the filter does not transmit.

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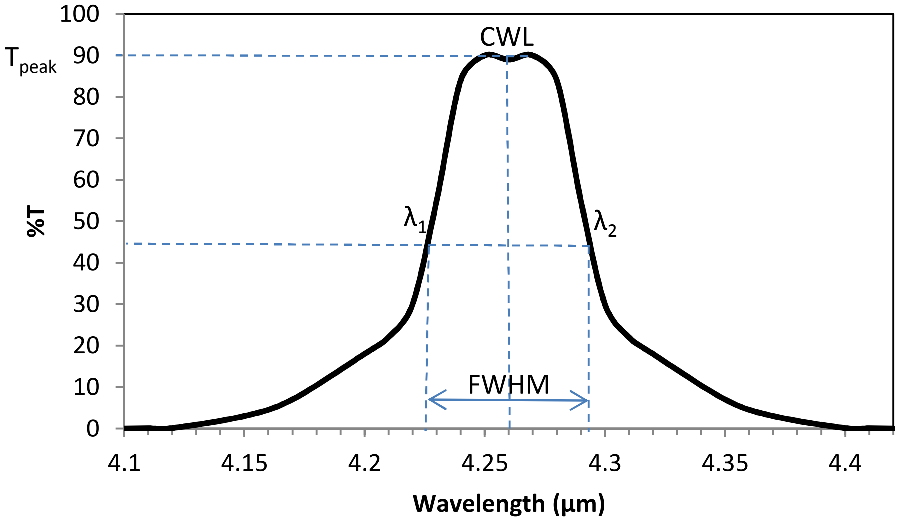

Figure 1: Typical spectral curves for a CO_2 bandpass filter.

λ_1 and λ_1 are the wavelengths where $\%\mathrm{T} = \frac{\mathrm{T_{peak}}}{2}$

$\mathrm{FWHM} = \lambda_1 - \lambda_1 = 4.283 - 4.237 = 46\ nm$

$\mathrm{CWL} = \frac{\lambda_2 - \lambda_2}{2} = \frac{4.283-4.237}{2} = 4.26\ \mu\mathrm{m}$

If filters are used at other than normal angles of incidence, the spectral characteristics will shift to shorter wavelengths as the angle of incidence deviates from normal. The effect can be approximately calculated by the following formula where n is the index of refraction.

$$\lambda_\Theta = \lambda_0 \frac{\sqrt{n^2 - sin^2\Theta}}{n}$$

For further information on any of the above, please contact Cambridge CMOS Sensors:

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