White Paper

AFBR-S20xxx

Absorbance, Transmission, and Reflection Spectroscopy

Introduction

Spectrometry involves the measurement of the intensity of light, and it is important to ensure that the spectrometer provides accurate results. In this white paper, we explain how to perform absorbance, transmission, and reflection measurements with Broadcom spectrometers using the Waves software.

Absorbance, transmission, and reflection spectroscopy is a commonly used measurement technique in analytical chemistry. In these measurements principles, light is directed from a broadband light source onto a sample. The spectrometer detects the absorbed or transmitted light of a sample. In the case of absorbance, the signal relates to the sample concentration and provides signification information about its chemical composition and physical properties.

How to Perform Absorbance and Transmission Measurements

To perform absorbance or transmission measurements, you need the following equipment at a minimum:

Light Source

For most applications that use this type of measurement technique, a broadband light source with a wide spectral range is a good choice. Alternatively, light sources with a smaller bandwidth, for example LEDs that match the wavelength region of interest, can be used.

Sample

Depending on your substance and the physical property (gas, fluid, solid), a suitable sample holder or sample chamber is needed. Determine what sample containment is the most suitable, and make sure that you select the correct material. For example, you cannot use a plastic cuvette for measuring UV signals because it will not let ultraviolet light through.

Spectrometer

Absorbance and transmission bands are found in many wavelengths from UV over Vis to NIR regions. Therefore, all Qseries spectrometers are a good choice. The spectrometer measures the intensity of the light that passes through the sample.

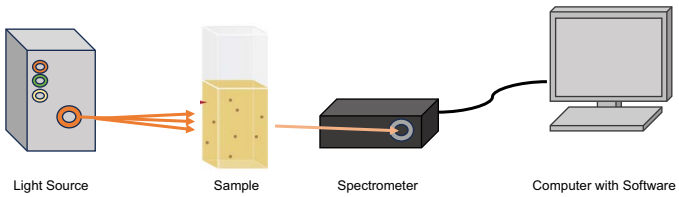
Fiber

Depending on your optical setup, you can work with an SMA 905 multimode fiber to guide the light between the emitter and the sample as well as between the sample and the spectrometer. Additional optics are another option to collimate the light beams properly through samples or to the spectrometer to perform accurate and reliable measurements.

Data Processing

You can easily transfer the measured data to a PC using a USB cable. The Broadcom Waves spectroscopy software helps to analyze the spectra. For industrial integration, you can also work with the other serial interfaces (UART and SPI) in combination with the Broadcom software development kit.

Measurement Setup



The transmittance is usually written as a percentage.

The spectral absorbance is sometimes defined as a base-10 logarithm and sometimes as a natural (base e) logarithm. In the Waves software, both options are available.

Performing the Measurement in the Waves Spectroscopy Software

1. To measure absorption, reflection, or transmission, first take a reference spectrum of the light source. If the measurement setup is not in complete darkness, take a background spectrum before the measurement.
2. The y-axis of the spectrum shows the intensity of the measured spectrum. To select a unit for relative measurements, navigate to the **Options** panel from the **File** menu, and select different units for displaying the spectra. The y-axis unit can be changed later from the **Properties** panel.
3. Use the auto-exposure function or manually adjust the exposure time to take a spectrum of the light source without the measurement sample. The light level should be within the linear range of the spectrometer, so that no saturation effects can influence your measurements. For best results, keep the adjusted exposure time for all the following measurements by selecting **manual** for the exposure selection.
4. To take a background spectrum, turn off the light source, keep the adjusted exposure time, and click **Take Background Spectrum** [] from the **Exposure** toolbar. To minimize noise, temporal averaging is recommended. If a background spectrum has been taken, select **Use Background Spectrum** []. If a spectrum is taken afterward, the background spectrum is automatically subtracted from the measured spectrum, eliminating unwanted background signals.
5. To take a reference spectrum for reflection spectroscopy, a white reference sample is required to calibrate the setup for 100% reflection. However, all real-world reference samples have a reflection of less than 100% and an uneven spectral distribution. Therefore, for accurate measurements, a reference spectrum must be supplied for the reference sample. To take a reference spectrum, place the white reference sample where the measured sample will be later placed. Then, keep the adjusted exposure time and temporal averaging, and click **Take Reference Spectrum** []. In the dialog window that follows, specify a data file that includes a calibrated spectrum of your reference sample. After selecting **Use Reference Spectrum** [], measure the reflectivity spectra.
6. To take a reference spectrum for transmission or absorption spectroscopy, turn on the light source again, remove the sample or replace it by a reference sample, keep the adjusted exposure time and temporal averaging, and click **Take Reference Spectrum** [] . After selecting **Use Reference Spectrum** [] , take spectra of the sample for measuring absorption or transmission.

   If the light source does not cover the full range of the spectrometer, the calculated spectrum may show large amounts of noise outside the wavelength range of the light source. This is normal and reflects the fact that the measurement has a large uncertainty at these wavelengths.
7. These measurements are quite sensitive to changes in the sample illumination. If in doubt, take another reference spectrum to ensure that it is still valid.

Accurate calibration and sample preparation are essential for measurement performance.

If you need any help, contact us at support.spectrometer@broadcom.com.