OSRAM
Opto Semiconductors

Infrared (IR) spectroscopy with the SFH4737 — Background & technology

Application Note

Valid for:
OSLON® P1616 SFH 4737

Abstract

Imagine you can check if the mangos on the market are sweet — without even touching them...

Imagine you can verify if your prescribed medical tablets contain the life-saving compound — or if the are counterfeits...

Imagine you can check the calories of your favorite cheese dish — before eating...

Imagine all this is possible with one fingertip on your smartphone...

The SFH 4737 is precisely designed to support this innovation.

This application note covers briefly the background of spectroscopy and the case for the broadband emitter series.

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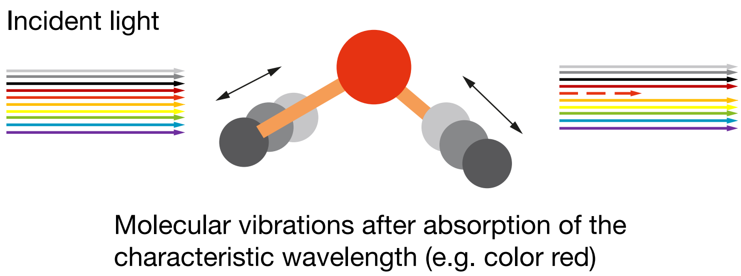
A. Infrared (IR) spectroscopy

To identify an unknown compound molecular spectroscopy based on infrared light can be used.

The physical principle is as follows:

Every molecule consists of several atoms. The bonds between the atoms can be excited by light with a characteristic wavelength (i.e. color). This leads to short time vibrations within the molecule (see Figure 1).

Figure 1: Only the characteristic wavelength will be absorbed by the molecule and leads to short term vibrations. This wavelength is unique and kind of “fingerprint” for the particular molecule/ compound



This specific wavelength depends on the strength of the bonds and the mass of the atoms and is very unique for each molecule. Since no two organic compounds have the same characteristics they can be identified with certainty by analyzing its absorption spectrum (see Figures 2 and 3) and matching it with a database.

Figure 2: Typical absorption spectrum vs. wavelength of pure water (H_2O) in the near-IR region. The peak at around 970 nm is characteristic for pure water

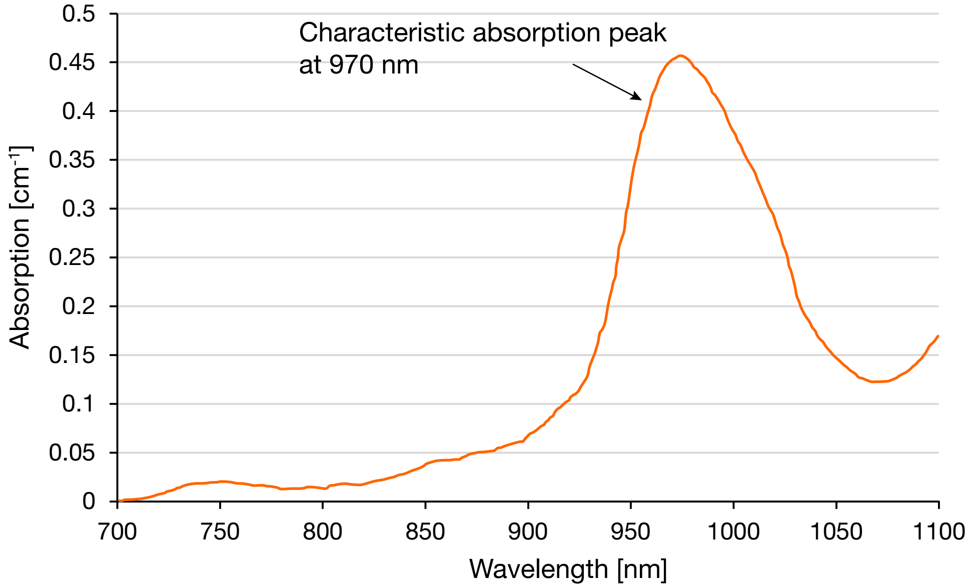
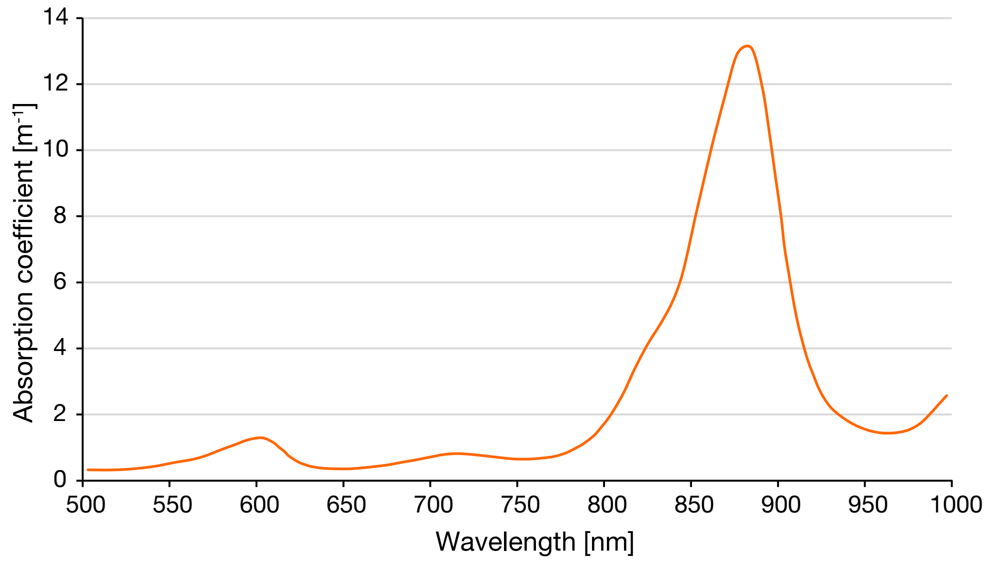


Figure 3: Typical absorption spectrum vs. wavelength of fat in the near-IR region



The most simple and natural of this system is the combination of sunlight and the human eye (see Figure 4). The sun acts as a “broadband” light source. It shines on e.g. roads and plants. Leaves absorb every color of the sunlight, except the green color (which gets reflected off the leaves). Then the human eye, acting as a wavelength selective detector (detecting blue, green and red, analogous to today’s digital cameras), receives (i.e. sees) only the green light. Thus we — as a human database — identify the leaf as green and usually (in combination with our knowledge) identify it as a leave. This is different to a dry brown leaf, which reflects different colors.

Figure 4: Kind of “natural” spectroscopy system

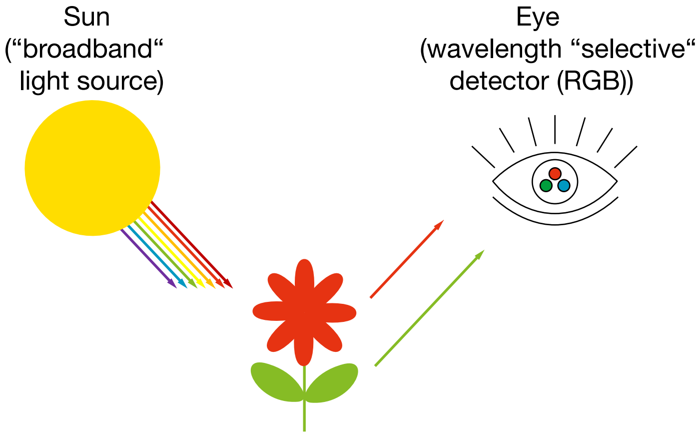
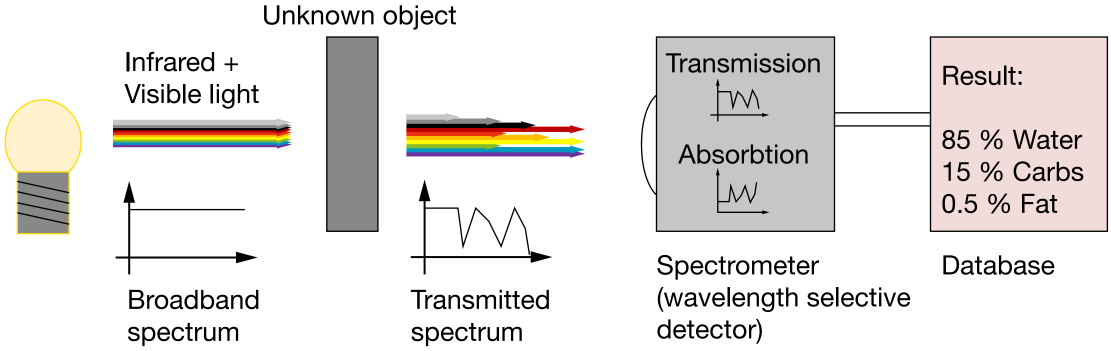


Figure 5 presents a simple technical realization of such an infrared spectroscopy system. It is an arrangement which works in transmission through the unknown compound. Alternative system realizations work in reflective mode.

Figure 5: Basic block diagram of a spectroscopy system. The light source is a broadband traditional light bulb which emits light from visible into infrared region. For near-IR systems the lamp can be replaced with the new broadband emitter series

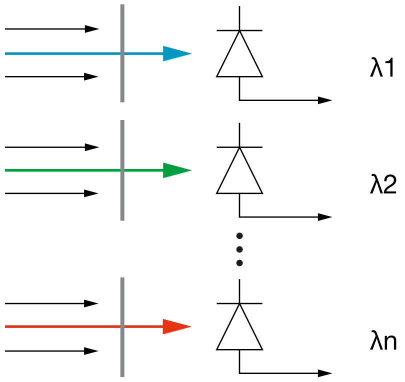


B. System components

There are several key components of such a system: The light source, the wavelength selective detector and the database to match the measured spectrum to identify the molecule.

The wavelength sensitive detector can be a (micro-) spectrometer with gratings to separate the wavelength’, a large monochromator or even a tiny photodiode array (e.g. CMOS camera chip) with wavelength selective filters on top of it (see Figure 6).

Figure 6: Simplified block diagram of a wavelength selective photodiode array based on selective filter elements



In traditional systems often light bulbs are used as their black body radiation is very broad and covers a wide wavelength range.

However, light bulbs are bulky and have only limited lifetime. While this is fine with laboratory instruments it is a blocking point for developing tiny handheld-style spectrometers.

To solve this problem, OSRAM Opto Semiconductors has developed a novel LED-based light source to enable development of ultra-compact IR-spectrometers which fit into smartphones or USB sticks.

Key requirements for such a solid-state broadband light source are:

- Broad wavelength range:

  Covering the near-IR range from 650 nm – 1050 nm perfectly matching the sensitivity of low-cost silicon-based detectors.

- Smooth spectrum:

  Covering the near-IR range with a stable spectrum without major dips and peaks.

- Long lifetime:

  No replacements of the light source anymore. This allows very compact module designs.

- Compact size:

  Allowing realization of ultra-compact spectrometers for implementation into smartphones.

- Blue background light:

  Allows the user to easily identify which compound is scanned and analyzed. The stylish blue light has same radiation characteristics as the invisible IR light.

- Small emitting size:

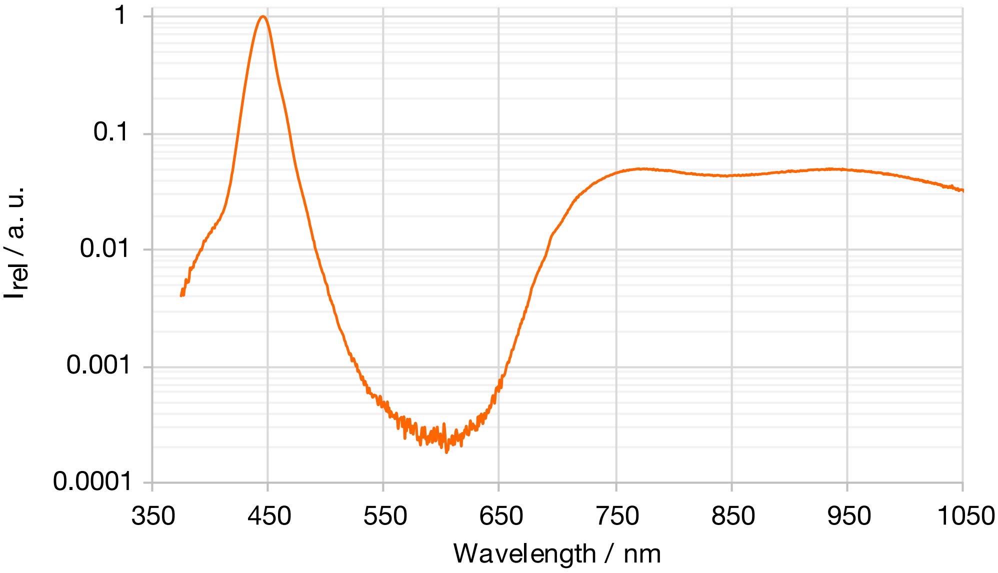
  A small emitting size (small etendue) vs. traditional light sources allows compact optics for tiny modules.

- Fast modulation capability:
  Allows modulation and short on-times to save valuable battery power vs. traditional light sources (even allowing compensation for ambient light).
- High efficiency:
  Particular suited for mobile applications to save battery power.
- Wide operating temperature range:
  Allows operation without active cooling (fan) for tiny module design.
- Low cost:
  Opens up new markets for spectroscopy. Bringing down system costs from thousands of $$ to single digit $$.

All the above requirements are met by the broadband near-IR light sources from OSRAM Opto Semiconductors.

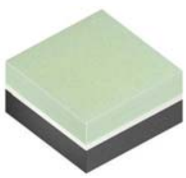
Figure 7 presents the typical spectrum of the SFH 4737. The spectral range has been designed to cover the complete near-IR range from 650 nm to 1050 nm to match the sensitivity of low cost Si-based detectors (e.g. modified CMOS-based camera sensors.)

Figure 7: Typical spectrum of the broadband near-IR LED SFH 4737.



The SFH 4737 is based on state-of-the-art OSRAM Opto Semiconductors conversion technology (Figure 8).

Figure 8: OSLON® P1616 SFH 4737



SFH 4737
OSLON® P1616

Don't forget: LED Light for you is your place to be whenever you are looking for information or worldwide partners for your LED Lighting project.

www.ledlightforyou.com

ABOUT OSRAM OPTO SEMICONDUCTORS

OSRAM, Munich, Germany is one of the two leading light manufacturers in the world. Its subsidiary, OSRAM Opto Semiconductors GmbH in Regensburg (Germany), offers its customers solutions based on semiconductor technology for lighting, sensor and visualization applications. OSRAM Opto Semiconductors has production sites in Regensburg (Germany), Penang (Malaysia) and Wuxi (China). Its headquarters for North America is in Sunnyvale (USA), and for Asia in Hong Kong. OSRAM Opto Semiconductors also has sales offices throughout the world. For more information go to www.osram-os.com.

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