CO_2 Measurement by

- InAsSb photovoltaic detectors
- Mid infrared LEDs

CONTENTS

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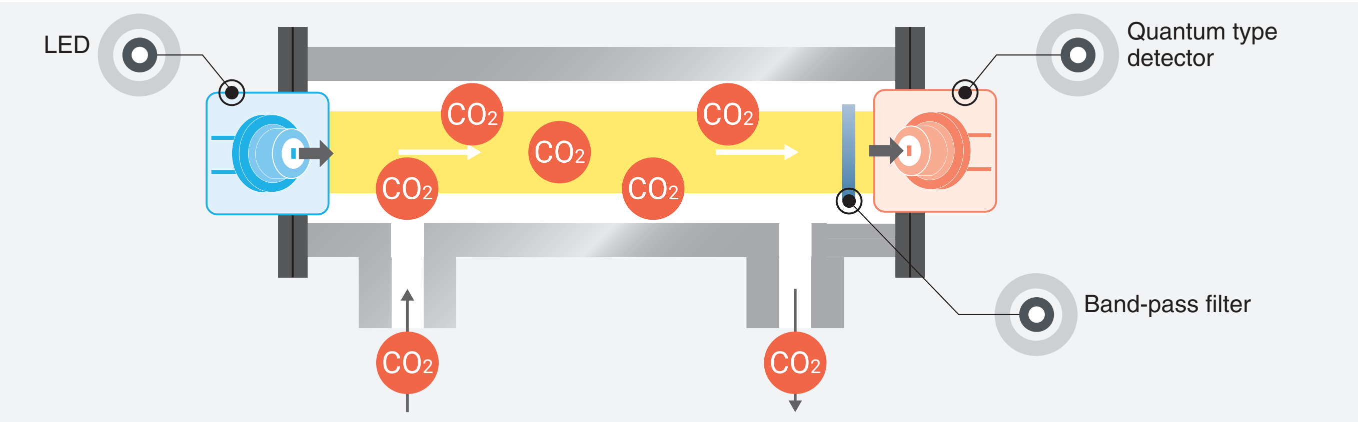
Principle of CO_2 measurement with NDIR method

In recent years, interest in gas analysis has risen due to its potential for application to the greenhouse gas problem and measures against infectious diseases. Hamamatsu Photonics handles photosensors and light sources suitable for gas analysis. Here, we introduce an example of CO_2 measurement using an InAsSb photovoltaic detector and a mid infrared LED.

NDIR method

NDIR (Non-Dispersive Infrared) detection method uses an optical filter to extract and detect only the wavelengths required for gas measurement. This method offers superior reliability and maintainability due to a simple detection principle, which uses no moving parts. Mostly containing cost-effective optical parts, it is non-dispersive and does not use image sensors. High cost performance optical parts are used in many measuring devices, including but not limited to portable measurement safety (explosive gas detection) devices and fixed environmental measurement devices.

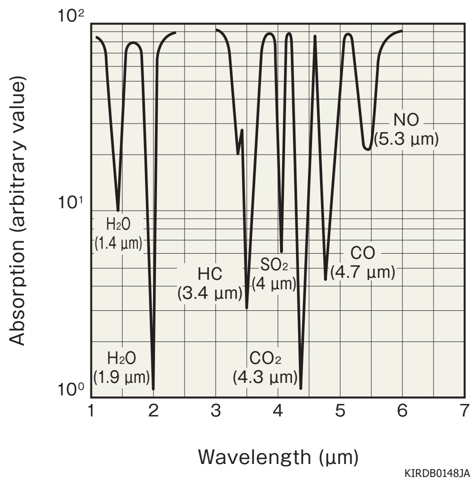


Since there is a CO_2 absorption band near the wavelength of 4.3 µm, light is absorbed by CO_2 when exposed to light in that wavelength region. The amount of light absorbed increases as the CO_2 concentration increases, and the CO_2 concentration can be measured from the change in the signal level of the photosensor due to changes in the amount of light absorption.

Photosensors and light sources commonly used in the NDIR method include a combination of a lamp and a thermal type detector such as a thermopile detector.

Combining a quantum type detector such as an InAsSb photovoltaic detector with a mid infrared LED will contribute to the compactness, high accuracy, and low power consumption of NDIR type gas sensors.

Gas absorption spectrum



Light source comparison

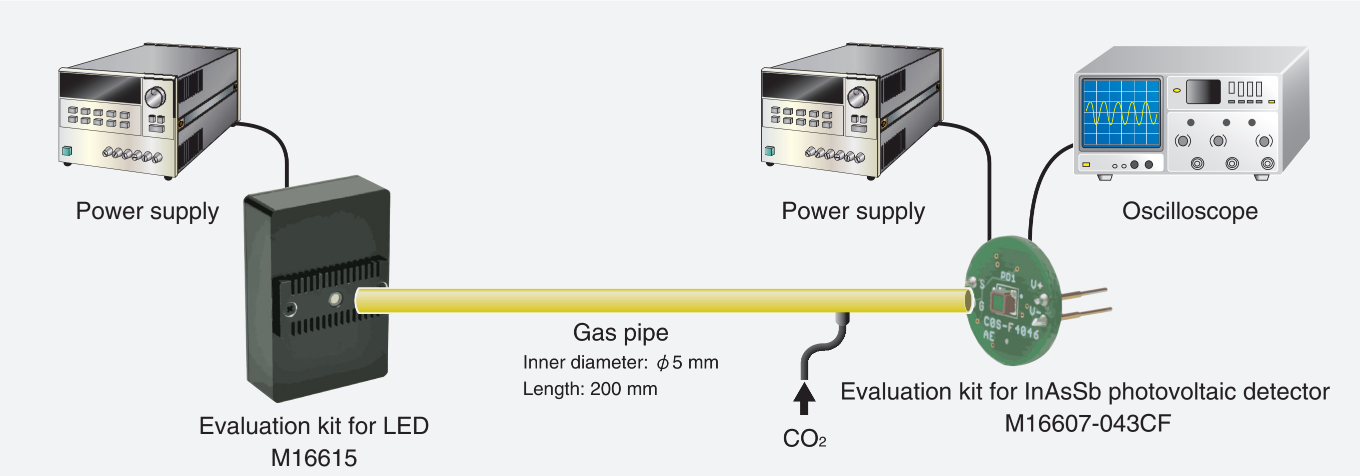
	Wavelength range	Output	Time response characteristics	Power consumption	Lifetime	Cost advantage
LEDs	Narrow	☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆
Lamps	Wide	☆☆☆☆☆	☆☆	☆	☆☆	☆☆

Photosensor comparison

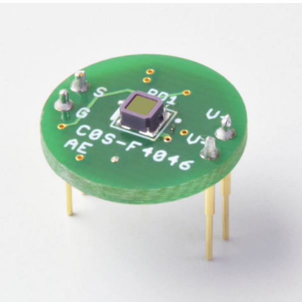
	Sensitivity	Wavelength dependence	Time response characteristics	Cooling	Cost advantage
Quantum type detectors	☆☆☆	Yes	☆☆☆☆	Required (partially not required)	☆☆
Thermal type detectors	☆☆	No	☆	Not required	☆☆☆

Structure of CO_2 measurement

■ Evaluation configuration (example)



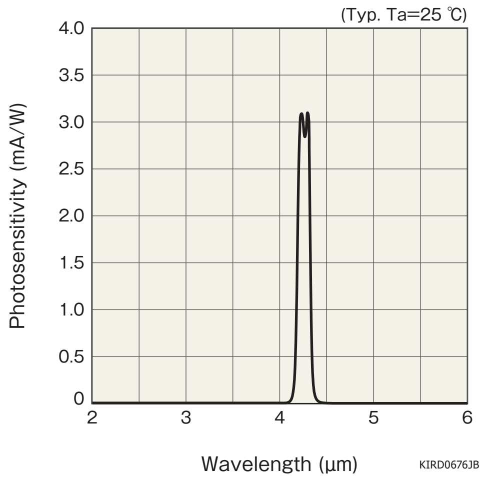
Evaluation kit for InAsSb photovoltaic detector M16607-043CF



- Built-in element: InAsSb photovoltaic detector P13243-043CF *1
- Band-pass filter center wavelength: 4.26 μm
- Gain: 30 V/V
- Average count: 1000 times
- Frequency characteristics: DC to 80 kHz
- Recommended drive voltage: ±15 V

*1: Click here for details on the InAsSb photovoltaic detector P13243-043CF
https://www.hamamatsu.com/jp/ja/product/optical-sensors/infrared-detector/inassb-photovoltaic-detector/P13243-043CF.html

■ Spectral response

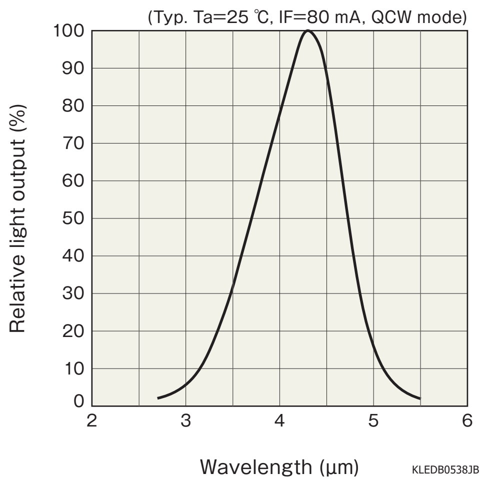


Evaluation kit for LED M16615

- Built-in element: Mid infrared LED L15895-0430M *2
- Peak emission wavelength: 4.3 μm
- Output current: 400 mA
- Output pulse: 10 μs
- Output cycle: 1000 μs
- Recommended drive voltage: +15 V

*2: Click here for details on the mid infrared LED L15895-0430M (sold separately)
https://www.hamamatsu.com/jp/ja/product/light-and-radiation-sources/led/L15895-0430M.html

■ Emission spectrum

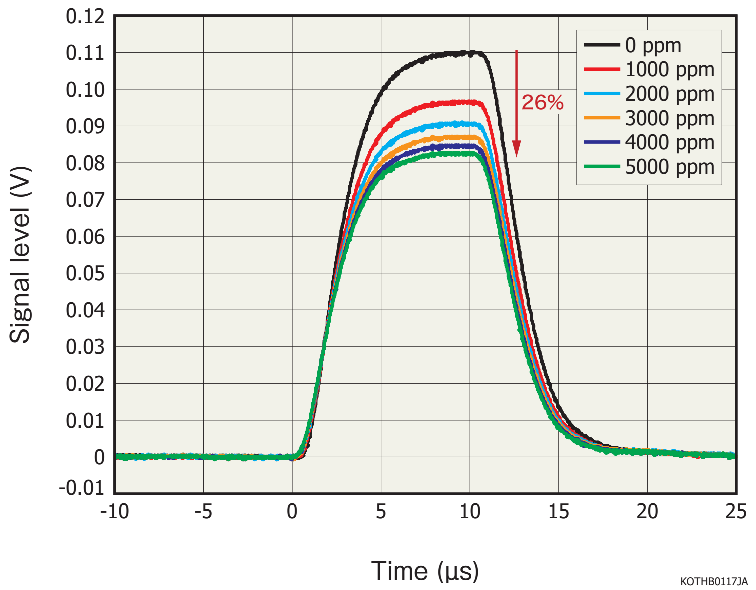


Example of CO_2 measurement

The following diagram shows the correlation between the results of measuring CO_2 with the structure on page 3 and the signal of the photosensor and the gas concentration.

■ CO_2 measurement result

As a result of measuring the signal by filling the gas pipe with CO_2 that has a concentration adjusted to 0 to 5000 ppm, we confirmed a 26% signal reduction due to the absorption of CO_2 in the gas pipe.



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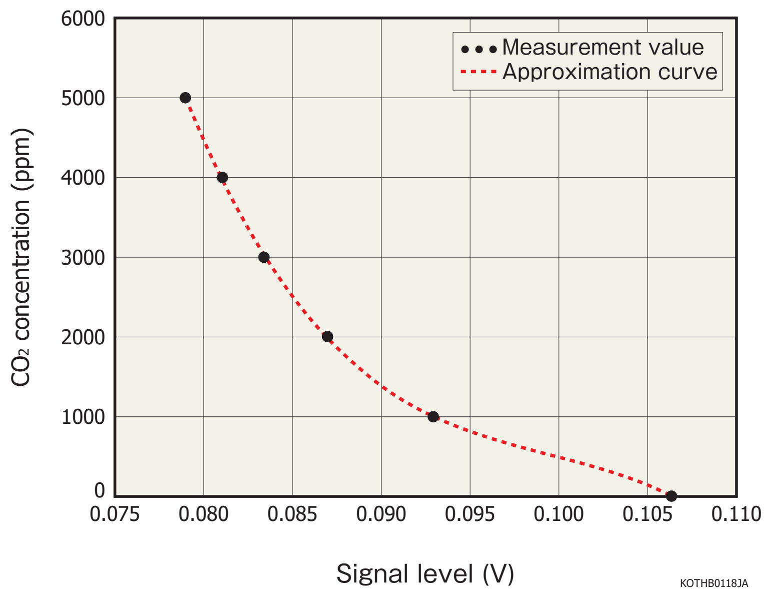
■ Correlation between the signal of the photosensor and gas concentration

The graph of the signal level of the photosensor in relation to the gas concentration nearly coincides the cubic approximate curve. Therefore, CO_2 concentration can be found by measuring the signal level of gas concentration.



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Hamamatsu offers mid-infrared LED with an emission wavelength of 3.9 µm and InAsSb photovoltaic detectors with a center wavelength of 3.9 µm for reference lights. Conversion to gas concentration with the use of the signal level of the wavelength (3.9 µm), in which CO_2 is not absorbed, makes contribution in measurement under the temperature changing environment and in measurement requiring higher accuracy.

■ Reference: CO_2 density and its impact

CO_2 density	Environment state
Approx. 400 ppm	CO_2 in the atmosphere
to 1000 ppm	Well-ventilated room
to 5000 ppm	Poorly ventilated room (headache or drowsiness)
5000 ppm or more	Limit value as a work place (based on regulations in Japan)
Approx. 40000 ppm	CO_2 contained in human exhaled breaths

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