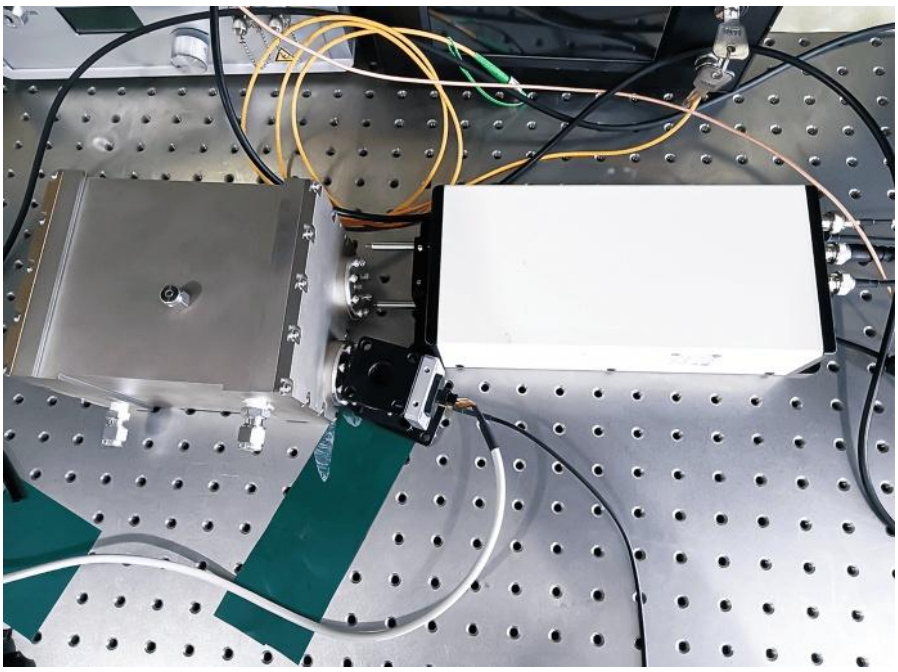
Mid-infrared TDLAS (sulfur dioxide) SO2 ppm level concentration analysis system



Product Description

TDLAS (Tunable Diode Laser Absorption Spectroscopy) is a new gas detection method developed on the basis of combining diode laser with long optical path absorption cell by modulating the wavelength of laser through the characteristic absorption area of the gas to be measured. The spectrum of the semiconductor laser light source used in TDLAS technology is much smaller than the broadening of the gas absorption spectrum, and a single-line absorption spectrum is obtained. Therefore, TDLAS technology is

a high-resolution absorption spectrum technology. Sulfur dioxide is a common, simple, irritating sulfur oxide, with the chemical formula SO2, a colorless gas, and one of the main atmospheric pollutants. Sulfur dioxide is a colorless, transparent gas with a pungent odor. It is soluble in water, ethanol, and ether.

Product features

Quantum cascade laser; long-path gas cell; broadband MCT detector; ppm-level high-precision detection; dust-resistant design

Part Number

MP-TDLAS-7400-SO2-MIR

Application area

Industrial Exhaust Gas Monitoring | Ambient Air Quality Monitoring | Flue Gas Desulfurization Efficiency Assessment | Chemical Process Control | Research-grade Gas Analysis

Core parameters

Wavelength
7.4um

General Parameters

Parameter

Theoretical basis:

1.Beer-Lambert law

When a laser beam passes through the measured gas with a concentration of C, when the wavelength of the laser is the same as the center frequency of a certain absorption spectrum line of the measured gas, the gas molecules will absorb photons and transition to a high energy level, which is manifested as the attenuation of the laser light intensity in the gas absorption band.

2.Wavelength modulation technology

It is to modulate the wavelength at high frequency and use harmonic detection technology to obtain the harmonic signal of the absorption spectrum through the phase-locked amplifier, and detect the concentration of the gas according to the peak value of the harmonic signal.

The key to wavelength modulation technology is the determination of the tuning band of the laser and the wavelength tuning characteristics. The characteristics of the laser can directly determine the type of gas detected, the accuracy of the detection system and the application field.Principles of absorption spectrum selection

When performing gas detection, the selection of absorption spectrum is very critical, and the following aspects should be considered

3. Harmonic detection theory

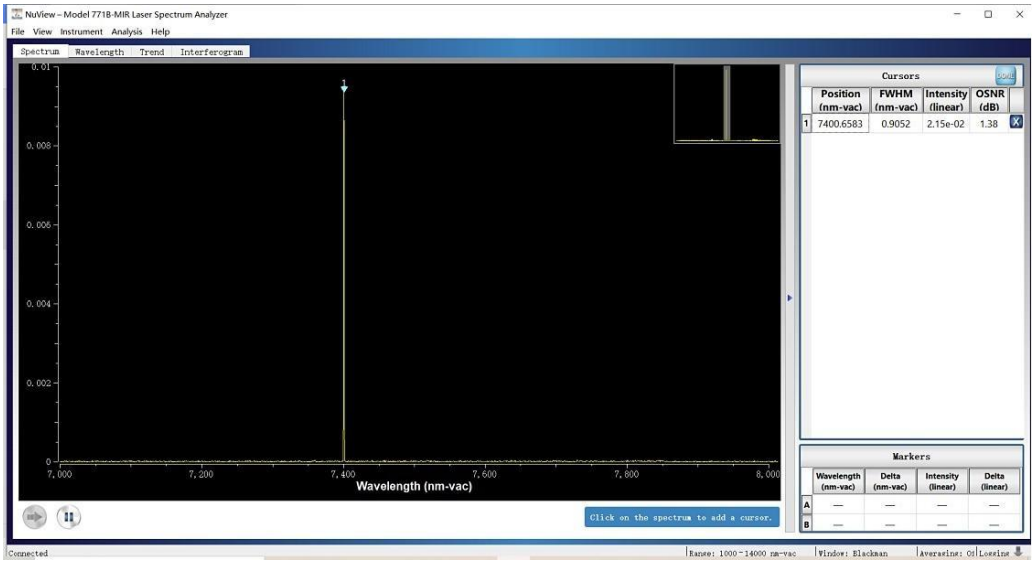
The acquisition of harmonic signals is achieved by using a phase-locked amplifier. The core function of the phase-locked amplifier is to perform phase-sensitive detection on the alternating signal. Since the laser is subjected to high-frequency sinusoidal modulation, the beam carries the frequency information of the sinusoidal modulation signal. Since the peak of the second harmonic line is at the center of the spectrum, it is symmetrical about the center of the spectrum. At the same time, among the even harmonics, the second harmonic spectrum has the strongest intensity and is easiest to obtain, so the second harmonic is used to detect gas.

Experimental instruments

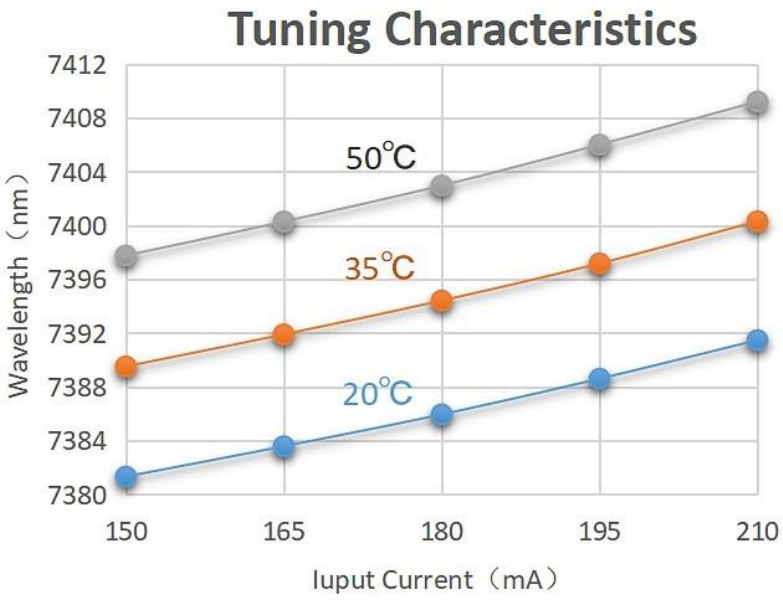
1. 7.4umQCL Quantum Cascade Laser

QCL7400 - 7.4um low-power desktop DFB-QCL mid-infrared quantum cascade laser is a domestically advanced low-power QCL DFB laser developed by Xiaoxiao in the first half of 2018. The tunable range exceeds 100nm, and the

output power is greater than 10mw to meet the industrial needs of customers testing gas sensors. Our laser collimated output has stable output power and high temperature and wavelength stability, which is several orders of magnitude higher than the stability of traditional high-power quantum cascade lasers. It provides the best test light source for our mid-infrared test customers.

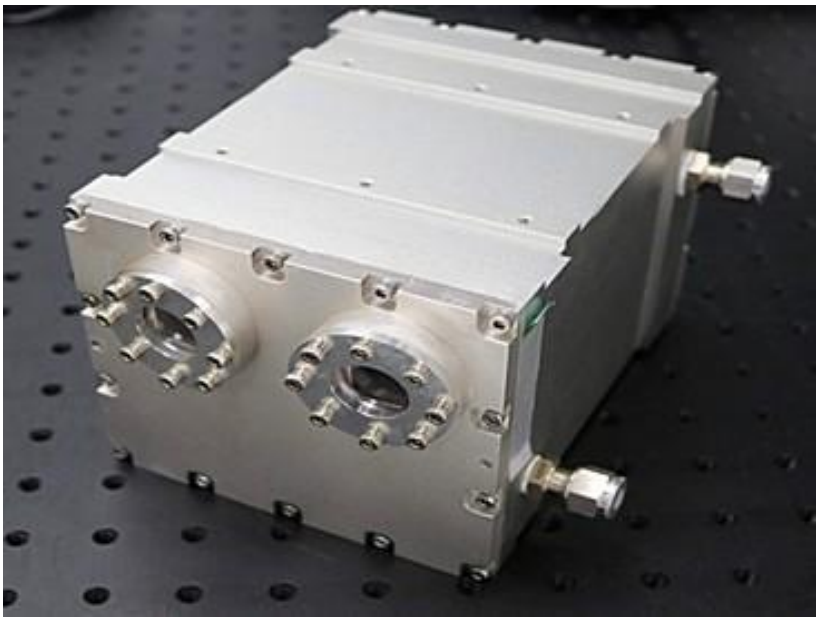


spectral



Wavelength Temperature Current Tuning Curve

2. Mid-infrared 5-meter optical path simple wave broadband gas chamber

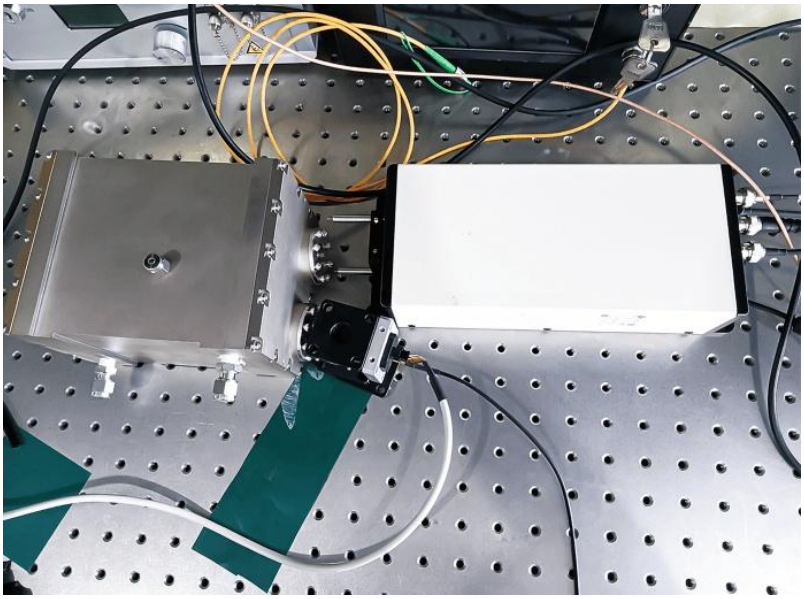


LD-PD simple wave broadband gas chamber is mainly used for infrared Fourier and other spectral technology applications. The gas chamber structure adopts a simple wave gas chamber structure, and the detection light is a mid-to-far infrared incoherent light source. In view of the needs of high temperature and corrosion resistance, in order to facilitate the measurement of the measured gas, the main body and optical components are developed with special metal materials that have been treated with corrosion resistance. It can work stably and reliably for a long time under the conditions of wet and hot corrosive gas, and accurately measure and analyze the main gas components including SO2, NOX, VOCS, NH3, O2, CO, CO2, HCL, H2O, etc.

3.Mercury Cadmium Telluride (MCT) Mid-Infrared Photodetector

The MCT-12-0TE amplified detector is a thermoelectrically cooled photoconductive HgCdTe (mercury cadmium telluride, MCT) detector. This material is sensitive to light waves in the mid-infrared spectral band from 2.0 to 12µm. A semiconductor refrigeration element (TEC) uses a thermistor feedback circuit to control the temperature of the detector element at -30 °C, thereby minimizing the effect of thermal changes on the output signal.

Experimental testing



Operation steps:

1) Plug the mid-infrared quantum cascade laser into the power cord, and connect the USB cable to the computer host; connect the MCT detector to the power cord

2) Connect the output line of the MCT detector to the PREAMP preamplifier port of the quantum cascade laser

3) Connect the TRIGGER trigger port of the quantum cascade laser to the oscilloscope CH1, and the DAC OUT second harmonic output port to the oscilloscope CH2

4) Align the output window of the laser with the input window of the simple wave gas chamber, and align the output port of the simple wave gas chamber with the MCT detector

5) Fill the simple wave gas chamber with a certain concentration of 200ppm SO_2 gas

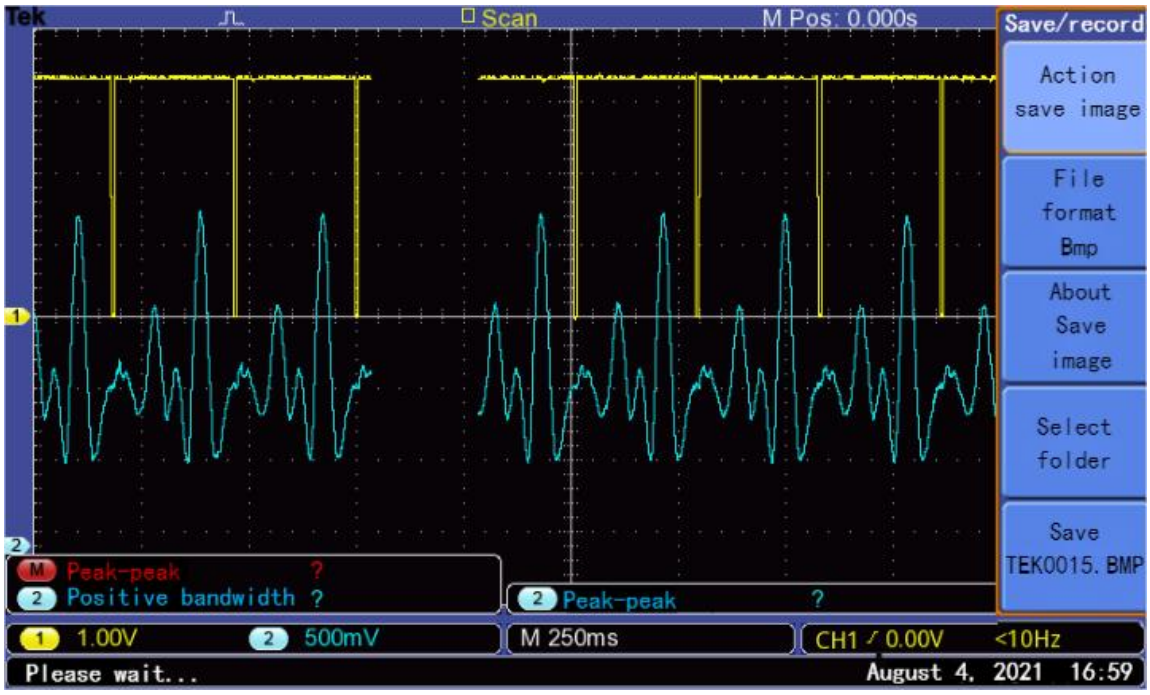
Process analysis:

Use the control software on the computer to adjust the current and temperature to tune the wavelength, so that the laser can scan a certain wavelength range, so that the output wavelength covers the absorption peak of the gas, and the phase-locked amplifier provides a high-frequency sinusoidal modulation signal to make the laser output frequency sinusoidally modulated. The light emitted by the laser passes through the gas absorption cell and enters the preamplifier

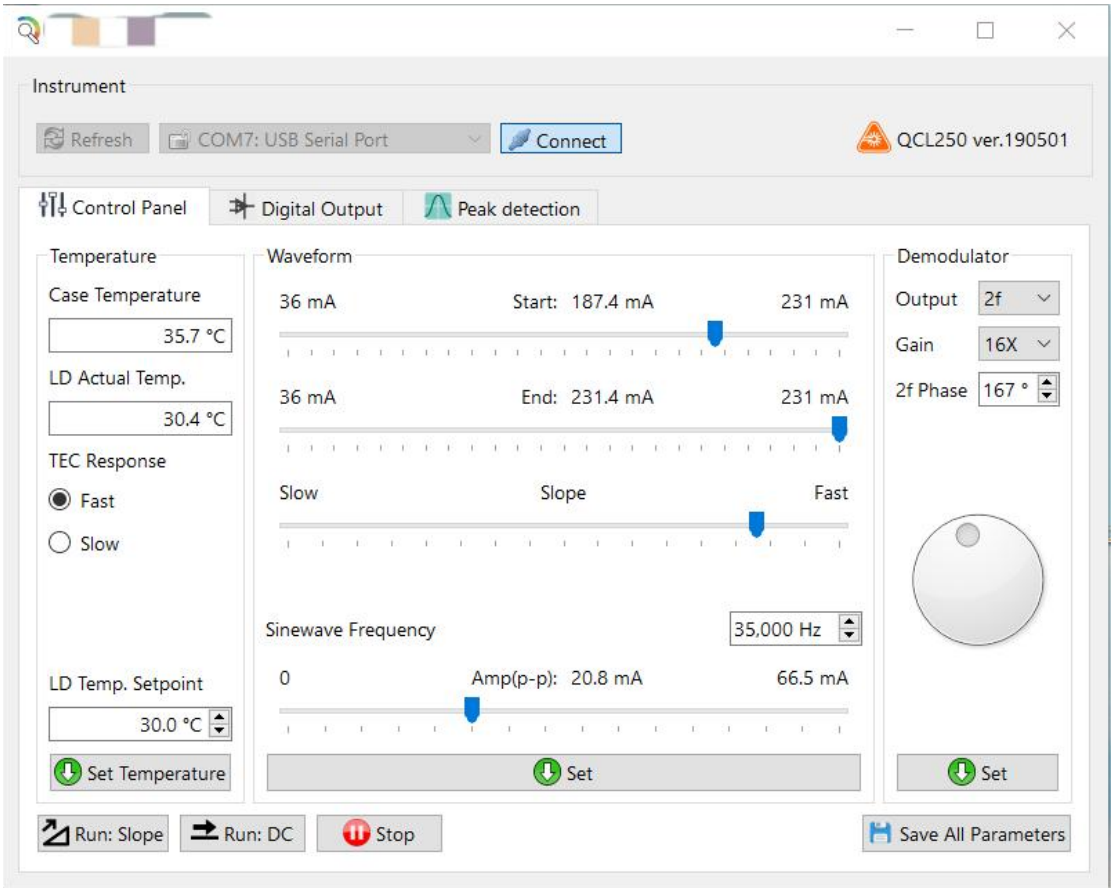
circuit at the PREAMP end through the detector, and then is modulated and demodulated by the phase-locked amplifier, and is output to the oscilloscope channel 2 through the DAC OUT analog output end to display the second harmonic signal. During the whole process, we adjusted various parameters in the software and observed the output waveform to optimize the output waveform.

Test results

1. The second harmonic waveform and modulation parameters are as follows:



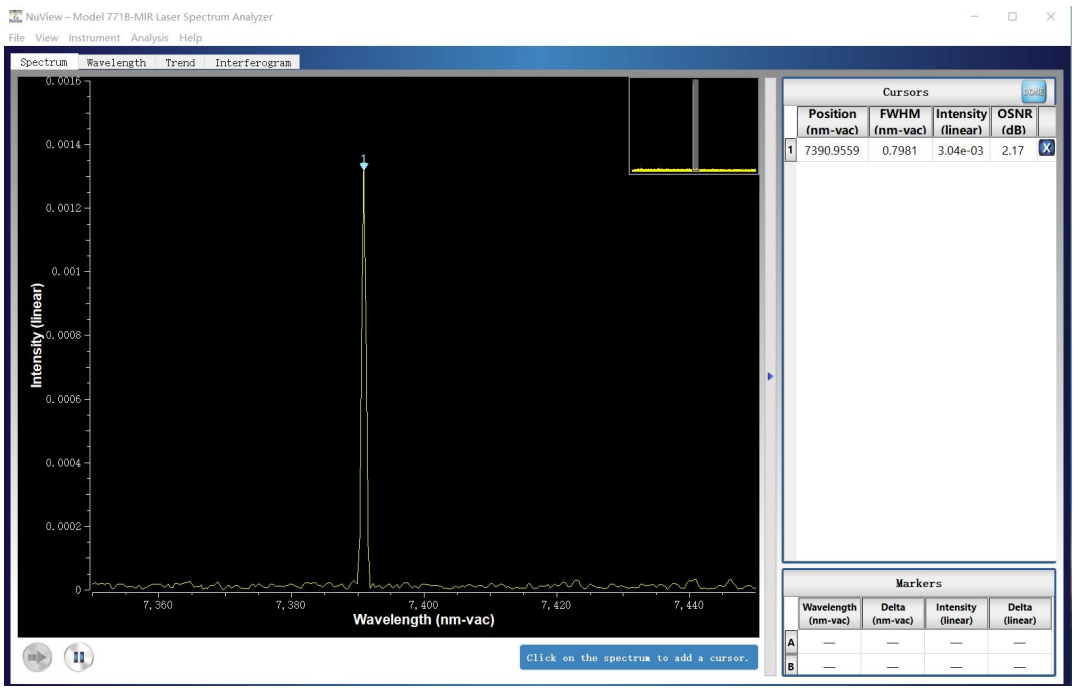
Second Harmonic



Software modulation parameters

Verification analysis:

In order to verify that the test signal is SO_2 gas, we used a wavelength meter to test the temperature at 30℃, and the corresponding wavelengths at the two points of scanning current at 187.4mA and 223.2mA were 7390.9559nm and 7397.3968nm respectively.

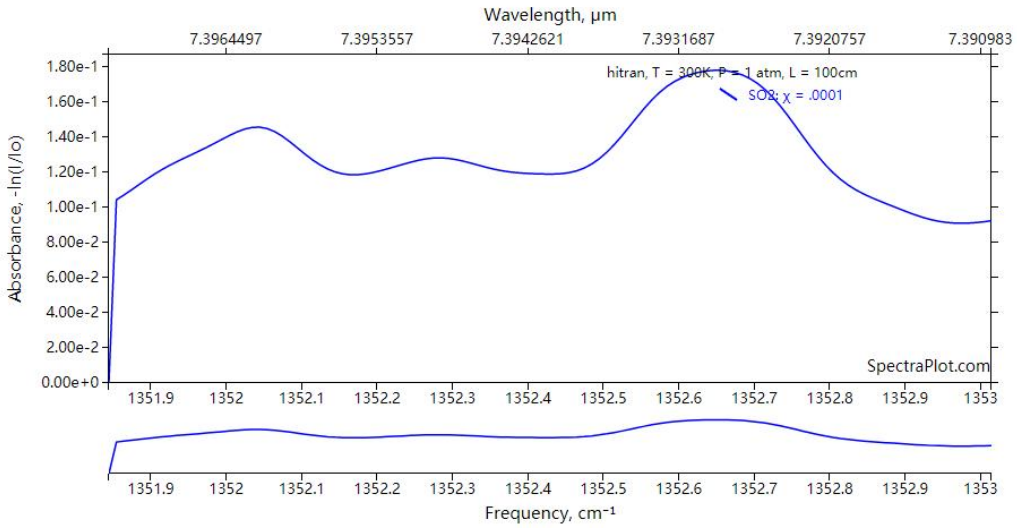


30deg, 187.4mA corresponding spectrum

MP-

30deg，223.2mA corresponding spectrum

By querying the Hitran database, the SO2 absorption lines in the wavelength range of 7390.9559nm and 7397.3968nm are as follows:



We compared the second harmonic amplitude information with the database and found that it was consistent with the database, thus verifying that it was SO_2 gas.

Experimental conclusion

Through testing, we found that when the SO2 concentration is 200ppm, the second harmonic amplitude can reach 1.8V, which shows that our mid-infrared TDLAS analysis system has high test accuracy and good test results.

Ordering Information

Product model: MP-TDLAS-7400-SO2-MIR

Product name: Near infrared TDLASSO2 ppm level concentration analysis system

SN#	Name	Describe
1	7.4um low-power desktop DFB-QCL mid-infrared quantum cascade laser	The laser module contains 7.4umQCL laser, laser drive, phase-locked amplifier, data acquisition function
2	Mid-infrared 5-meter optical path simple wave broadband gas cell	Wavelength range 2~12um; effective optical path 5m; input maximum optical power 500mW; insertion loss ≤5dB; material 316L;

		gas port diameter 6mm; spatial optical access
3	2-12μm mercury cadmium telluride (MCT) mid-infrared photodetector with amplification and TEC	MCT detector; response wavelength range 2.0-12μm; peak wavelength 10.6μm; relative response intensity 0.26A/W@10.6um; photosensitive surface size 1X1mm;
4	USB flash drive	Optical window WZNSEAR