App Note: DLS-02

DFB Laser for Methane (CH_4) Gas Sensing

1. Introduction

1.1 Methane (CH_4) is one of the most important organic molecules on earth, produced by many natural and human-influenced sources. Accurate and real-time detection of methane gas becomes critical for natural gas pipelines leakage monitoring, household safety, coal mining safety production monitoring, etc.

1.2 Absorption Spectroscopy is a powerful method for measuring trace gas concentrations over distances or within difficult environments. Methane have several strong absorption lines in the 1653 nm regime in the Hitran database. Using the technology of tunable diode laser absorption spectroscopy (TDLAS), a Distributed Feedback (DFB) Laser is used as the light source of the methane gas sensor.

1.3 DenseLight's 1653.7 nm DFB Lasers are used extensively for high sensitivity methane detection in the applications where the amount of methane needs to be exactly measured. By tuning temperature and driver current of the DFB laser device, real-time and online detection of methane concentration could be realized, providing additional advantages of full concentration detection range, high precision, good selectivity, immunity to other gases, long calibration cycle, etc.

2. Assembly Guidance

2.1 DenseLight supplies 1653.7 nm DFB laser devices in TO-can for customers to integrate with ease to make commercialized methane gas sensors. With DenseLight's packing knowledge, other packaging types could be customized upon request.

2.2 Successful die attach is one of the key steps for packaging, by precisely carrying out the die attach at dwell temperature of 310˚C - 360˚C for 35 seconds. It is important that temperature change rate should not be greater than 7˚C per second to avoid any damages to the coating by over expansion of the die.

2.3 With Denselight packaging expertise, emission point of 1653.7 nm DFB laser is matched precisely to the focal point of lens, if lens assembly is required. Figure 1 shows the drawing of 250 µm x 200 µm laser diode chip with emission point and optical axis highlighted.

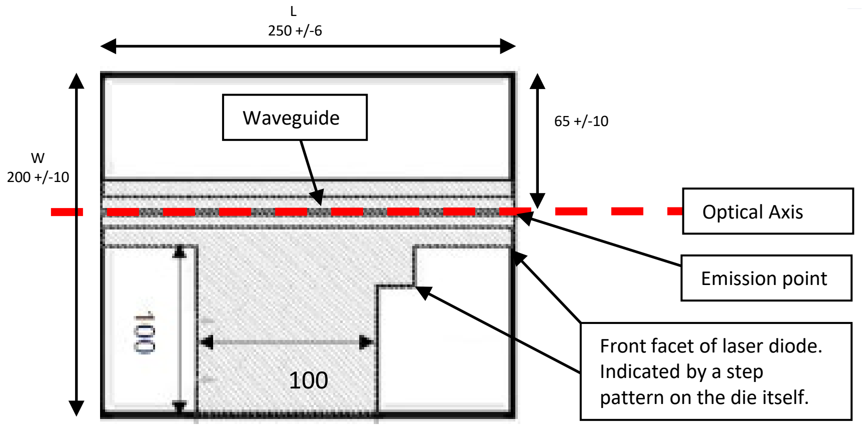

Figure 1: Drawing of 250 µm x 200 µm laser diode chip with emission point and optical axis

3. Laser Device Testing Tips

3.1 It is important to carry out verification test on the DFB laser device performance with the correct setup at chip on submount (COS) as well as packaged TO-can. Figure 2 shows a recommended verification test setup for TO-can. It is recommended to use an Integrating Sphere to measure power, otherwise, lower power might be observed due to incomplete capture of the light, hence the power measured may not be accurate.

3.2 To optimize the testing with simulated end use applications, good heatsinking of the TO-header is necessary by thermally contacting the TO-header to a suitable heatsink, as illustrated in Figure 2. The wavelength tuning range might be significantly narrowed without adequate heatsinking.

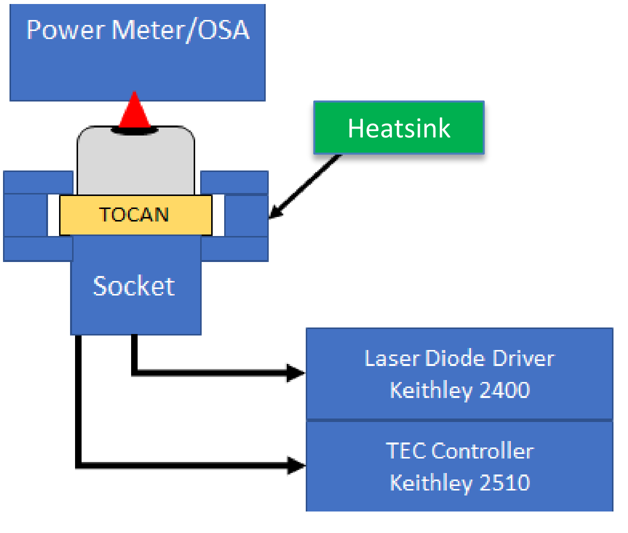

Figure 2: Illustrative testing set-up for 1653nm DFB device packaged in TO-can

4. Optimizing Lasing Performance

4.1 To achieve the desired performance of 1653.7 nm DFB laser, *i.e.*, minimum output power & side mode suppression ratio (SMSR), it is compulsory to drive the device under the operation conditions specified in DenseLight's data sheet.

4.2 Different methane sensing applications require different lens depending on the applications, *i.e.*, fixed-point or remote detection, as well as gas cell design. When ordering Denselight's 1653 nm DFB TO packaged devices, it is important to specify the working distance and light beam spot size required so that the optimum packaging type to meet the application could be advised.

5. Wavelength Tunability Tips

5.1 In order to accurately detect methane gas, the DFB laser needs to perform stable and precise lasing at 1653.7 nm, where wavelength tunability could be achieved by changing thermoelectric cooler (TEC) temperature and operating current.

5.2 DenseLight's go-to-market TO-can packages use high performance fit-to-purpose TEC which enables performance of the DFB laser device over the temperature tuning range from 5˚C (with heatsink) to 45˚C, which enables the wavelength to be tuned to exact 1653.7 nm. The key considerations for selection of TEC are deltaT (temperature that the TEC can maintain between hot and cold side when under heat loaded conditions) and sufficient power handling capacity. To ensure the performance of the 1653.7 nm DFB devices, it would be necessary to conduct verification test on the TEC performance at the packaged laser for customers who are doing the packaging by themselves.

5.3 Figure 3 shows an example of precise tuning of wavelength to 1653.7 nm. The central wavelength at TEC temperature of 25˚C with bias current of 35mA is 1652.05 nm, and is tuned to 1653.59 nm by tuning the TEC temperature to 40˚C alone. A fine tuning to achieve 1653.7 nm is then completed by increasing the bias current to 37.93mA.

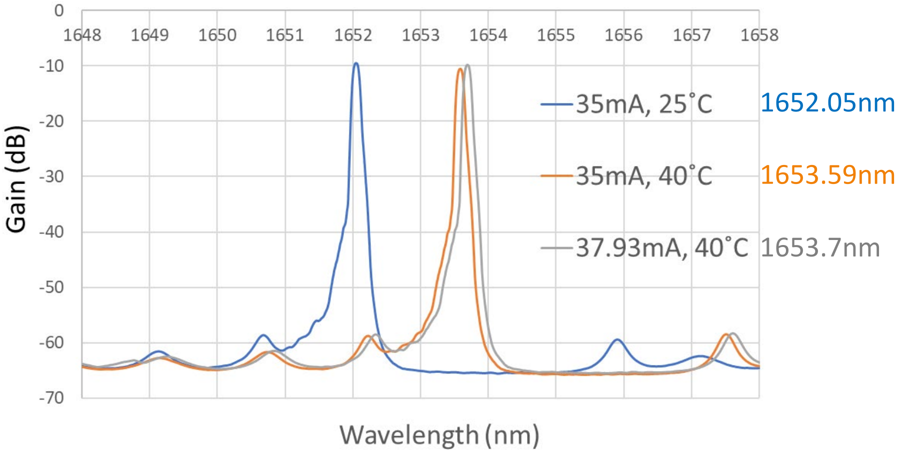

Figure 3: Precise tuning of wavelength to 1653.7 nm via TEC and current tuning