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Yanfang Li, Lin Chang, Yuejin Zhao, xiangjun Meng, Yubin Wei, xiaosong Wang, Jianhui Yue, Tongyu Liu

PII: S0263-2241(15)00511-4
DOI: http://dx.doi.org/10.1016/j.measurement.2015.09.044
Reference: MEASUR 3600

To appear in: *Measurement*

Please cite this article as: Y. Li, L. Chang, Y. Zhao, x. Meng, Y. Wei, x. Wang, J. Yue, T. Liu, A fibre optic methane sensor based on wavelength adaptive vertical cavity surface emitting laser without thermoelectric cooler, *Measurement* (2015), doi: http://dx.doi.org/10.1016/j.measurement.2015.09.044

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Yanfang.Li *[a,b], Lin.Chang[c] ,Yuejin Zhao[a], xiangjun Meng[d],Yubin.Wei[b], xiaosong.Wang[e], Jianhui.Yue[b], Tongyu.Liu[b]

[a] School of Optoelectronics of Beijing Institute of Technology, 5 South Zhongguancun Street, Haidian District, Beijing, 100081, China.

[b]Shandong Key Laboratory of Optical Fiber Sensing Technologies, Laser Institute of Shandong Academy of Sciences, Jinan, Shandong, 250014, China.

[c] Mining Products Safety Approval and Certification Center (MA Center), No.5 Qingniangou Rd, Hepingli, Beijing, 100013,China.

[d] China Yankuang Group，No.298, Fushan South Road, Zoucheng City, Shandong Province, 273500, China.

[e] Changzhou Research Institute Limited Company of China Coal Technology，No.1, Mushu Road, Changzhou, Jiangsu, 213015 , China.

ABSTRACT

Based on tunable diode laser absorption spectroscopy (TDLAS) technique and the feature of Vertical Cavity Surface Emitting Laser (VCSEL) wavelength scanning range up to dozens of nanometer, methane detection technique based on wavelength adaptive VCSEL without Thermoelectric Cooler (TEC), is proposed, then the laser methane sensor system design is followed. The reliability experiments study under variety of environments in laboratory, such as temperature impact test, damp heat, cyclic and dusty impact test and so on, were carried out. And then the test data and some analysis were given. These data verified the feasibility of the wavelength adaptive technique, and these data showed the laser methane sensor can provide long working time without any calibration, and they have the advantages of high accuracy and stability.

Keywords: TDLAS, wavelength adaptive, VCSEL, TEC, Laser methane sensor,

1. INTRODUCTION

Methane (CH4) is a colorless, odorless gas, which is lighter than air. It is the principal component of natural gas. Methane widely exists in our life and it is one of the main components of greenhouse gases. This gas is not only an explosive but also acts as asphyxiate; it can therefore cause serious harm to human's health and our home. Therefore the methane detection is very essentially required in the areas like in coal mines, power plant, waste water treatment and petroleum chemical industry, etc [1]. With the development of optical fiber technique and semiconductor laser technology, Tunable Diode Laser Absorption Spectroscopy (TDLAS) has become an important direction in the field of methane detection.

TDLAS was first put forward in the 1970s by Hinkley and Reid [2]. With the continuous development of the technology, more and more kinds of gases can be detected, such as O_2, H_2O, CO, CO_2, SO_2 and NOx, which is higher content or pollution gases in the atmosphere [3-6]. Especially in the recent years, the rapid development of optoelectronic technique and optical communication technology, makes the tunable semiconductor laser has the characteristics of small size, long life and high power, and this further promote the application in the field of industry, environment and medical science. TDLAS is developing follow the direction such as various gases detection at the same time, miniaturization and remote detection with open light path [7-9].

At present, to keep the output wavelength and the intensity of light not affected by temperature, a high precision temperature control system is generally needed in TDLAS gas detection system. This not only increased the complexity but also greatly raised the overall power consumption of the system, especially the startup power consumption even is few times as much as the system work normally. This greatly restricted the promotion of this technique and the development of portable products. As we all know, VCSEL has the feature that the wavelength scanning range could up to dozens of nanometer through scanning the current and the temperature. In this paper, A VCSEL without TEC is selected as the system light, and the laser worked is a free state. By introducing a wavelength feedback of reference gas

The authors acknowledge the support of Shandong Province independent innovation and achievements of special (2014ZZCX03405)

yanfang.li@sdlaser.cn