STABILIZATION OF THE COHERENT EMITTER PARAMETERS FOR GAS SENSORS

S. F. Vieru, A. V. Dorogan, T. S. Vieru, V. V. Dorogan

Technical University of Moldova, Chisinau, Moldova
E-mail: optolab@mail.ru, dorogan_lme@yahoo.com

The paper presents the results of stabilization of parameters and characteristics of Vertical Cavity Surface Emitting Laser (VCSEL) Diode to use in gas detectors on the basis of the tunable diode laser spectroscopy method (TDLS). In order to determine the gas concentration with TDLS, a single-mode, tunable diode laser is wavelength - centered onto one of the fine absorption lines of the target gas. The laser is driven to obtain wavelength modulation and scan absorption lines within a very narrow range. Absorption of infrared light with specified wavelength by the target gas molecules leads to a decrease of intensity on a detector, depending on the gas concentration.

Precise absorption spectra were obtained to determine the optimal wavelengths for gas sensing. The measured absorption spectrum of NH_3 shows the possibility of using lasers with different wavelengths emission in the range of 1490-1550 nm for NH_3 detection, where NH_3 absorption prevail over other gases.

Laser diode for TDLS has to processes: single-mode emission; sliding wavelength; high efficiency; low divergence; low power consumption; high temperature stability; low cost. The studied VCSEL device structure had been manufactored at Ecole Polytechnique Fédérale de Lausanne, Laboratory of Physics of Nanostructures in the framework of the SCOPES project [1]. The measurements had been carried out for the chips of laser devices and the encapsulated VCSEL module contains a photodiode for monitoring the emission power, thermistor and TEC for monitoring and controlling temperature of the chip.

The tunable diode laser spectroscopy method requires a high accuracy of stabilization and control of temperature and operating current the emitter, which specify and can modulate the emission wavelength. The installation to manage the VCSEL emitter and to measure of gas sensor signal by TDLS method was created (fig. 1).

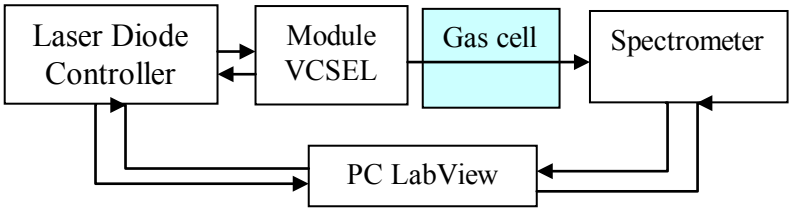

Fig. 1. Flowchart of measurement system for the study of gas sensitivity

The use of LabView enables the optimal quantity of the equipment, detectors, and characteristic devices for research, management, monitoring, reporting directly importing data and graphs in Excel, to communicate with the computer, analyze the output data. This advantage significantly reduces equipment costs and the time for analysis and reporting.

The system stabilizes the operating current with accuracy of 10 μA. The use of temperature stabilization unit with TEC can set and maintain the temperature in the range –40 to 120 °C with a precision of 0,1. The developed software makes it possible to carry out a series of automated measurements at predetermined pitch temperature and current.

The encapsulated VCSEL modules were mounted on a stage in a setup used for measuring the emission spectra at operating current variations in the 5–15 mA range, with a 1 mA step and temperature values 17 °C, 20 °C, 22 °C. The increase of the operating current from 5 mA up to 15 mA has demonstrated a variation of the emitted wavelength in the range of 1531.7 – 1534.8 nm at the temperature 22 °C that is enough for gas absorption line scanning (fig. 2).

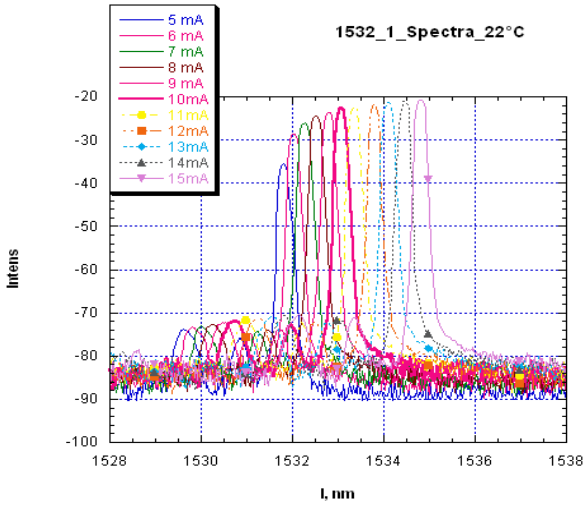

Fig. 2. Emission spectra of the VCSEL module at operating current values 5 – 15 mA and 22 °C

The analysis of the encapsulated VCSEL modules had demonstrated possibility of continuous change of emission wavelength with operation current, which allows efficient use of VCSEL for ammoniac detection by TDLS method.

ACKNOWLEDGMENTS

The research was performed at Ecole Polytechnique Fédérale de Lausanne (EPFL), Laboratory of Physics of Nanostructures and at Technical University of Moldova in the framework of the SCOPES project.

1. *Syrbu A., Mircea A., Mereuta A. et al.* // IEEE Photon. Technol. Letters. 2004. Nr. 14. P. 738–740.