VCSEL STUDY FOR GAS SENSING USAGE

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A widely favored approach to accurate and sensitive gas concentration measurement is the tunable diode laser spectroscopy (TDLS). Laser diode for TDLS has to processes: single-mode emission; sliding wavelength; high efficiency; low divergence; low power consumption; high temperature stability; low cost. We studied the parameters and characteristics of the Vertical Cavity Surface Emitting Lasers (VCSELs) to estimate the features and their applications in gas detection and the TDLS method. 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 (fig. 1).
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 LIV characteristics of VCSEL chips had been created for a wider operating temperature range (5°C – 70°C) in order to determine the maximum output emission power and threshold current. The result demonstrates that the optimal temperature regime for a satisfactory functioning of VCSEL lasers represents the temperature values 30-40°C if taking into account the usage in gas sensors. The emission power decreases essentially at temperature values higher than 50°C. The emission spectra measurements had been carried out for several samples of the VCSEL chips, which possessed single mode and maximum emission power values in order to determine the value of the applied current and operating temperature values for stabilization of the VCSEL laser emission around the 1512 nm wavelength value. The obtained results (fig. 2) show that a single mode emission regime of the studied VCSEL lasers is present for the current values in the 5mA – 11mA range and the operating temperatures in the 15 – 25°C range.

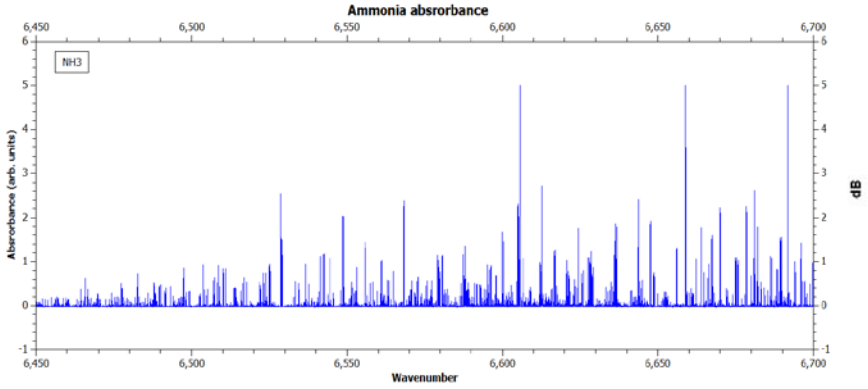

Fig.1. The measured with high precision absorption spectrum of ammoniac in the range of 1490-1550 nm (6450 – 6700 cm-1).

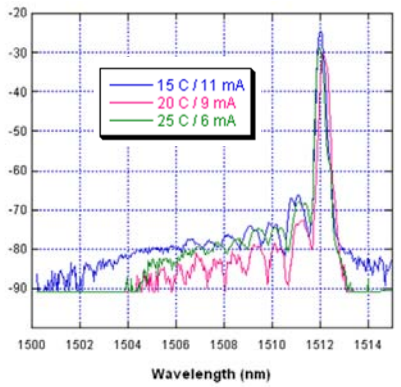

Fig.2. Stabilization at 1512nm emission power of VCSEL chip.

The encapsulated VCSEL module contains a photodiode for monitoring the emission power, thermistor and TEC for monitoring and controlling temperature of the chip. During repeated measurements it was observed that the VCSEL is very sensible to the optical feedback of the mounted setup used. Different leaser modes and external resonator modes were being amplified at different time values, which lead to instability of the emission. The measurements carried out on the encapsulated VCSEL modules had demonstrated high Side-Mode Suppression Ratio (SMSR is above 40 dB), high temperature stability of the emission wavelength (dλ/dT0.05 –0.08 nm/K), possibility of continuous change of emission wavelength with operation current, what allows efficient use of VCSEL for ammoniac detection by TDLS method. The increase of the operating current from 5mA up to 15mA 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.

[1] A.Syrbu, A. Mircea , A.Mereuta , A. Caliman , C.-A. Berseth, G. Suruceanu, V.Iakovlev, M.Achtenhagen , A.Rudra, and E. Kapon, *IEEE Photon. Technol. Letters*, 14, 738-740, (2004).