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Single channel gas analyzers based on immersion lens Mid-IR diode optopairs

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Optical sensing, that is, chemical composition determination through the use of spectroscopic/transmission measurements is becoming more and more attractive due to fascinating improvement of the performance of diode lasers, light emitting diodes (LEDs) and photodiodes (PDs). The latter are of particular importance since photovoltaic operation mode leads to a minimum noise that is beyond the capabilities of photoresistors, thermopiles and bolometers.

Recent years have seen extensive research of the mid-IR (3-14 μm) diode optopair, i.e. an optically coupled source and detector assembly that contains p-n junctions which can effect each other via electrically generated or/and absorbed photons. Diode optopairs in this wavelength range which allow the introduction of a gas or a liquid sample under investigation into the optical path, or in other words "diode optopair sensors" are of particular interest for environmental monitoring. This is because most industrial gases/liquids have characteristic absorption bands in the above spectral range and because the atmospheric transparency in two bands ("windows") at 3-5 (I) and 8-14 (II) μm allow the use of long paths for transmission measurements and hence the detection of trace gases.

Recently we have achieved remarkable LED/photodiode performance improvement due to the implementation of the immersion lens technology and flip-chip mounting of devices that are active in the 3-5 μm spectral range [1]. However, temperature instability of the signals was a headache for the engineers designing measuring instruments [2]. Recently it appeared that the above devices lacked any noticeable degradation at moderate operation modes and have foreseeable parameters in the temperature range of -10…+60 C. The latter enabled us to introduce two parameter calibration function (S=S(t, I), where S - is the photodetector signal of the optically coupled diode pair, t- is the temperature and I- is the LED current) into a gas concentration calculation procedure in a single optopair gas analyzer that does not contain power hungry thermoelectric coolers for temperature stabilization.

The report will present data on temperature variation and stability of the immersion lens diodes and optically coupled diode pairs at different operation modes fabricated from InAs, InAsSb based heterostructures and emitting at 3.3 and 4.3 μm wavelengths as well as long term stability measurements of the CH4 and CO2 gas analyzers. Related issues such as simulations of the diode pair analyzer sensitivity to different gases that take into account broad band LED emission and multiple peak assembly of the gas absorption will be also discussed.

References

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