The Microprocessor CO_2 Concentration Sensor Based on Heterostructure Optopairs

Konstantin J. Avdonkin, Vladimir K. Makukha, *Member, IEEE*
Novosibirsk State Technical University, Novosibirsk, Russia.

***Abstract*—Some variants of realization of capnometric sensors based on heterostructure optopairs are presented. Parameters of optical system are calculated. Characteristics of sensors are investigated. Microprocessor system of sensor control and input data processing are developed.**

ONE OF THE MAIN problems of modern medicine is diagnostics of a human's body physiologic state. It is quite important for such fields of medicine as intensive therapy and anesthesiology in which doctors should to estimate a condition of the patient, being guided only on indications of the devices, supervising the basic vital functions of the person. Capnometry serves as the valuable diagnostic tool, allowing not only to monitor functions of system of breath, but also to diagnose cardiac abnormalities.

Capnometeres working on a principle of infraread (IR) spectroscopy are most a wide distributed in the world's medical practice. The essence of this method is ability of carbonic gas to absorb infra-red radiation on some lengths of waves (the strongest absorption is observed at wavelengths 2.7 and 4.27 microns). All below considered sensors work at an absorption line 4.27 microns. Seemingly, it is easier, from point of view of optical system creation, to use more short-wave line 2.7 microns. But it has one serious lack - at this wavelength water vapor, which, naturally, also is contained in air, exhaled by the person, has strong absorption.

One of widespread IR sources of radiation in such devices is the filament. Probably, it is possible to attribute to it only one advantage - simplicity. Among lacks are the big dimensions, high power consumption, a wide spectrum of radiation, inertia (necessity of mechanical modulation of a light beam). As IR radiation receivers can be used various devices: bolometers, photoresistors, photo diodes, pyrometric, opto- acoustical and photoelectronic receivers.

Now in an instrument's producing industry the tendency to transfer to devices with low power consumption, small voltage and, naturally, small sizes is observed. New technologies have appeared in producing In(Ga)As and InAsSb heterostructure photodiodes (PD) and light emitting diodes (LED) [1]. Tiny semiconductor LED and PD have a number of advantages. Among them are possibility to work with low energy consumption, a low voltage, weak temperature dependence, a narrow spectrum of radiation, an opportunity to work in a continuous or pulse mode (that, for example, allows to proceed from mechanical modulation to electronic one).

In this paper variants of sensors on basis LED and PD, developed in Ioffe Physico-Technical Institute (IPTI) of Russian Academy of Sciences (Centre of Nanoheterostructure Physics) and on a basis «not cooled two-element differential device for CO_2 sensor» manufactured in "ICO" company (both – St. Petersburg) will be considered.

The device of "ICO" represents 2 LED and 2 PD. PD are located on one chip (to compensate significant temperature drift of parameters). Manufacturers recommend to use the two-channel optical scheme of the sensor (fig. 1): CO_2 concentration in the reference channel is equal to zero, and in measuring channel there is a investigated gas mix.

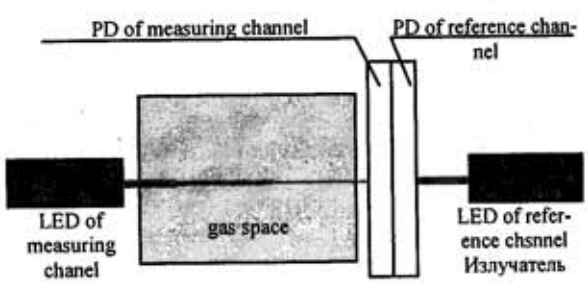

Fig. 1. The optical circuit of the sensor

The sensor based on LED and PD, developed in IPTI, has weak dependence on temperature and consequently there is an opportunity to construct the sensor with the single-channel optical scheme. Both the radiator and a photo detector of this sensor are supplied with an immersion lenses that provides favorable conditions for radiation collecting. Parameters of optopairs are resulted in table 1.

A cell with measured gas plays important role in an optical scheme of the instrument. In a design of

ISSN 1815-3712 ISBN 5-7782-0491-4