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Oxygen detection using a differential Helmholtz-based photoacoustic sensor operating in the 760 nm range

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Breathe analysis is a major topic for the study of living systems, since it provides direct information on health and life quality of animals in laboratories, in particular for metabolic studies.

We report here the development of a differential photoacoustic (PA) sensor based on a Helmholtz-type resonator and on a VCSEL laser emitting in the 760 nm range. This type of resonator is made of two volumes connected by a thin duct. Among others, its most interesting property for differential measurements is that the acoustic wave in one volume is π-shifted with respect to the other volume at the resonant frequency. Such a Helmholtz resonator is therefore an intrinsically differential system if the 2 gas samples are separately inserted into each of the 2 volumes.

A membrane, tuned at the same resonant frequency than the cell, is placed mid-way of the connecting duct, playing the double role of separating the gas mixtures of the two volumes (e.g. inspired air in one, expired air in the other) and keeping the acoustic coupling between them, in order to still exploit the acoustic enhancement at resonance and to keep the phase-shifting equal to π.

First photoacoustic measurements for differential oxygen detection are reported here, showing a promising potential for the breathe analysis application.