TECHNOLOGY OFFER

Features & Benefits

- Ultra-small sample volume
- Fast sensor response, low sample diversion
- High sensitivity – shot noise limited detection
- High dynamic range – over a few orders of magnitude
- Robust sensor – applicable in harsh environments
- High potential for miniaturization – down to chip integration

Users & Application

- Suitable for a wide range of applications with the need of sensitive and robust gas detection, additionally featuring a small footprint; e.g. industrial process control, environmental monitoring, medical diagnostics, or scientific research

Status – our offer

- R&D – Cooperation
- Patent pending

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Highly Sensitive Gas Detection

Balanced Detection Cavity Assisted Photothermal Interferometric Spectroscopy – A method for robust trace gas sensing within an ultra-small sample volume

A Fabry-Perot interferometer serves as excellent transducer for sensitive gas detection by application of photothermal spectroscopy. This method features the highly appreciated property of an ultra-low absorption volume within a rugged sensing element. The presented technology reports on the implementation of balanced detection to this basic photothermal spectroscopy configuration. By this means, noise sources which severely limit the sensor performance of the prior art, are effectively canceled.

Background
Any photo-induced heating of a sample gas caused by absorption of radiation leads to a change of its refractive index. Photothermal spectroscopy employs an excitation laser for sample heating and a probe laser to monitor resulting changes. A refractive index change in turn causes a phase shift of electro-magnetic waves passing through the heated region. This can be measured precisely by monitoring intensity changes of the probe laser through an interferometer. In this regard, the use of a Fabry-Perot interfero-meter, i.e. an optical cavity, features the outstanding characteristic for sensor miniaturization; any loss in sensitivity caused

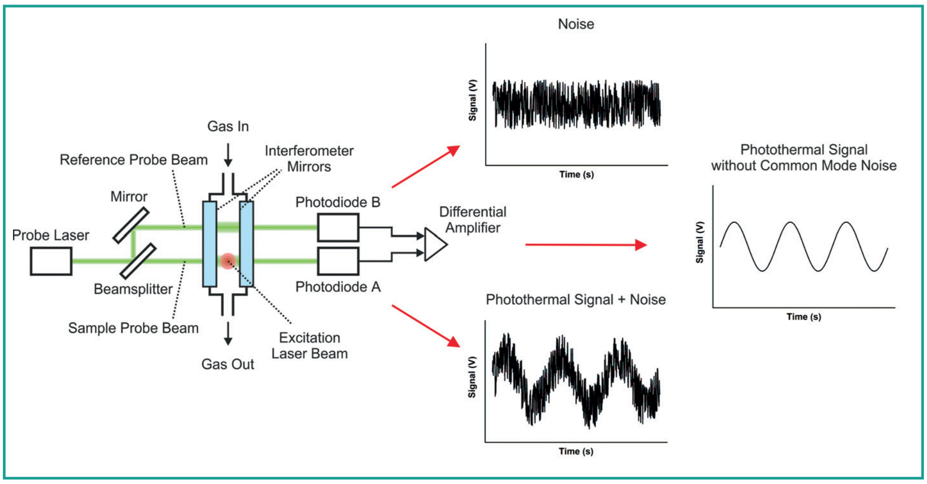

Figure 1 Balanced detection CAPTIS scheme; the probe beam is split into a sample probe beam and a reference probe beam. The sample beam probes the photothermal signal, which is superimposed by noise, whereas the reference beam only probes noise. By differential amplification of the two photodiode signals the photothermal signal is recorded along with high rejection of common mode noise.

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by a short interferometer spacing (e.g. 1 mm) can simply be compensated by an increased reflectivity of the cavity mirrors. A drawback of this cavity assisted photothermal interferometric spectroscopy (CAPTIS) scheme is the increased noise level, which severely limits the sensitivity and ruggedness of such a sensor.

Improvement

The novel implementation of a balanced detection scheme to the CAPTIS method enhances the senor performance by efficient cancellation of probe laser and environmental noise, see Fig. 1. Within this scheme, the probe beam is split into two parts, which are both transmitted through a cavity of identical characteristics. Their intensities are simultaneously compared, which allows to effectively cancel noise and to extract a photo-induced signal with upmost sensitivity. When applying balanced detection CAPTIS, identical characteristics of the two cavities – which also includes identical sample gas and pressure inside the interferometers – are essential for simultaneous noise rejection. This is especially of high relevance for applications, where fast changes of the target molecule and/or the matrix occur.

Benefit

The presented method combines the advantages of conventional photothermal spectroscopy employing a Fabry-Perot interferometer as transducer together with the merits arising by balanced detection. By this means, robust and highly sensitive detection of gases within an ultra-small absorption volume can be performed. The implemented balanced detection scheme does not only greatly enhance the signal-to-noise-ratio by recovering tiny photothermal signals, but also enhances the ruggedness of the sensor to environmental perturbations by rejection of external noise sources.

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