



Absorption mask for high sensitivity laser spectroscopic trace gas analysis

Invention

We introduce an absorption mask which significantly improves the performance of multi-pass cells for laser absorption spectroscopy. The patented mask is a simple inset for state of the art multi-pass cells. It is designed to allow the propagation of the main optical beam within the cell, while effectively blocking unwanted stray light. Fringes caused by interference of the stray light and the main beam (left figure below) are suppressed, revealing the undisturbed absorption spectrum (right figure below). Thereby, the absorption mask strongly improves the sensitivity of trace gas analysis by laser absorption spectroscopy.

Background

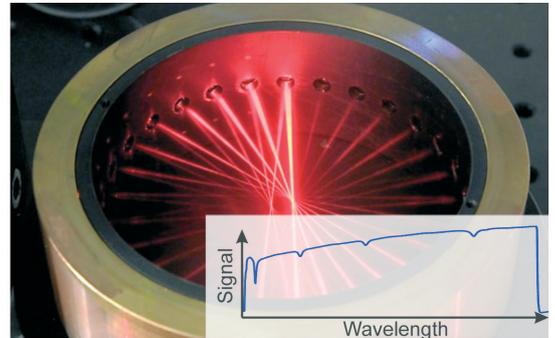
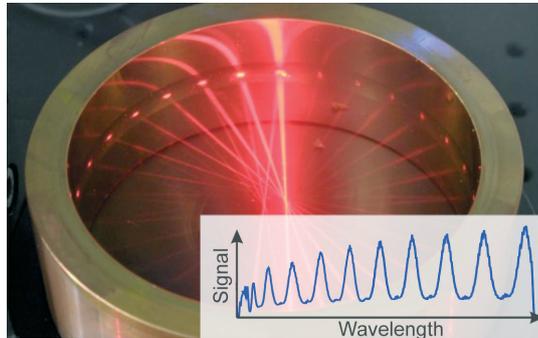
Mid-infrared laser spectroscopy is widely used to monitor trace gas species in industrial, medical, and environmental applications. Very frequently, multi-pass optical cells are employed to enhance the instrumental sensitivity and analytical precision. Such multi-pass cells are mostly based on the designs of White [1] and Herriott [2]. Recently, we proposed an absorption cell consisting of one seamless, toroidal ring mirror [3]. This design is highly attractive because it is robust, small, and cost effective. However, its sensitivity is limited by strong fringes caused by the interference of stray light with the main light beam. This limitation can be overcome by the introduction of our absorption mask. While the mask is especially useful for toroidal ring mirror cells, it can also be employed for other multi-pass cell designs such as White, Herriott, and astigmatic cells.

Advantages

The new absorption mask greatly improves the applicability of a multitude of existing and future designs of multi-pass cells for laser absorption spectroscopy. As a simple inset to the cell it can be easily applied to existing or new setups. Its material may be freely chosen as long as it is absorbing or can be coated with an absorbing layer. Therefore, the production of the mask is simple and inexpensive and it is suitable for mass production.

Applications

Since the invention is suited for any multi-pass cell design, it can improve the performance and reduce the cost of gas analysers in many applications of laser absorption spectroscopy significantly. Examples include instruments for breath analysis, mobile pollutant detectors for measurement networks, or sensors for industrial process control.



Ownership

Empa, Swiss Federal Laboratories for Materials Science and Technology, Überlandstrasse 129, CH-8600 Dübendorf; *Patent pending*

References

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- [2] D. Herriott, H. Kogelnik, R. Kompfner, Appl. Opt. 3, 523 (1964).
- [3] B. Tuzson, M. Mangold, H. Looser, A. Manninen, L. Emmenegger, Opt. Lett. 38, 257 (2013).

Keywords

Laser absorption spectroscopy, optical detector, trace gas analysis, multi-pass absorption cell, stray light, interference.

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