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For further information visit our website
www.ir-workshop.info

Important Dates

- Paper and Poster Submission: July 10, 2016 NEW
- Paper and Poster Acceptance: August 5, 2016
- Registration Acceptance: August 12, 2016
- WORKshop Start: November 7, 2016

Please submit your abstracts to a.kuck@lasercomponents.com
A template can be downloaded from the WORKshop website

IR Filters

IR Emitters

IR Detectors

IR

3rd International WORKshop on Infrared Technologies

November 7–8, 2016

Call for Papers

NEW DEADLINE
JULY 10, 2016

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General Information

1. The official language is English.
2. The WORKshop fee is 200 € + VAT. Invoices will be sent immediately after registration acceptance. This is due within 30 days. The fee includes participation at the WORKshop, a book of abstracts, coffee breaks, lunch, and the monday evening get-together.
3. The fee will be waived for all participants with an accepted paper or poster.
4. All slots for oral presentations are 15 minutes in total, 12 minutes for a presentation and 3 minutes for discussion. Please ensure that presentations do not over-run!
5. New poster concept: 3 minutes of oral presentation with 3 slides. There will be up to 3 presentations prior to each break. Poster authors will then be "marked" for the break so that they can be identified easily and contacted for more detailed discussions. All printouts of the presenters material will be provided. Changes of this procedure are reserved by the advisory board.
6. The WORKshop is limited to a total number of 80 attendees including advisory board and organizers. All participants with an accepted paper or poster automatically receive registration acceptance.
7. Bowling and Bavarian buffet is scheduled for the monday evening get-together.
8. The WORKshop dress code is informal. There is no real chance to change clothing between WORKshop and bowling.

Compact mid-IR sensors based on bi-functional and commutable semiconductor lasers and detectors on the same chip

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ABSTRACT

Optical sensors for mid-infrared spectroscopy are widely used in industrial and environmental monitoring as well as medical and biochemical diagnostics. Conventional optical sensing setups include a light source, a light-analyte interaction region and a separate detector. We present a sensor concept, based on bi-functional quantum cascade heterostructures, for which the differentiation between laser and detector is eliminated. This enables mutual commutation of laser and detector, simplifies remote sensing setups and facilitates a crucial miniaturization of sensing devices.

INTRODUCTION

Quantum cascade based mid-infrared spectroscopy [1] has become a reliable and versatile tool for chemical sensing in a variety of fields. Quantum cascade lasers (QCLs) excel with their compactness and tailorable emission characteristics throughout a wide range of the infrared electromagnetic spectrum. The unbiased semiconductor heterostructure is capable of detecting incoming radiation. Such quantum cascade detectors (QCDs) exhibit an inherent Stark-induced shift of the detection frequency compared with the lasing frequency. The development of bi-functional quantum cascade heterostructures [2] allows compensation of this wavelength mismatch and enable a monolithic integration of laser and detector on the same chip. Based on such bi-functional quantum cascade heterostructures, the specific sensor design strongly depends on the application at hand.

SENSORS

Liquid sensing utilizing bi-functional quantum cascade lasers/detectors (QCLDs) can be realized on a single chip as shown in Fig. 1. Typical analyte interaction lengths for gas sensing are in the range of tens of centimeters

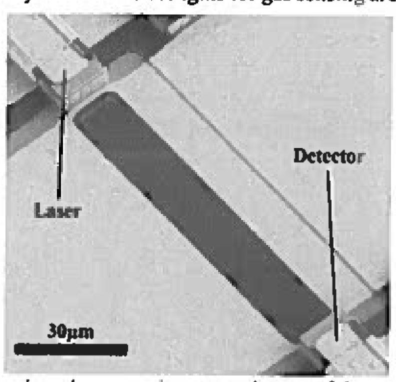

Figure 1: Scanning electron microscope image of the on-chip sensor for liquids based on bi-functional QCLDs.

or more and exceed the common semiconductor chip sizes. Our gas sensing approach incorporates surface-active lasers and detectors [3], which enables to remove the light-analyte interaction region from the chip. This sensor consists of two concentric ring QCLDs with second order distributed feedback (DFB) gratings on top of the waveguides. These DFB gratings facilitate vertical light emission [4] and detection in the biased lasing and unbiased detector configuration, respectively. A sketch of our sensor is given in Fig. 2(a). The engineered

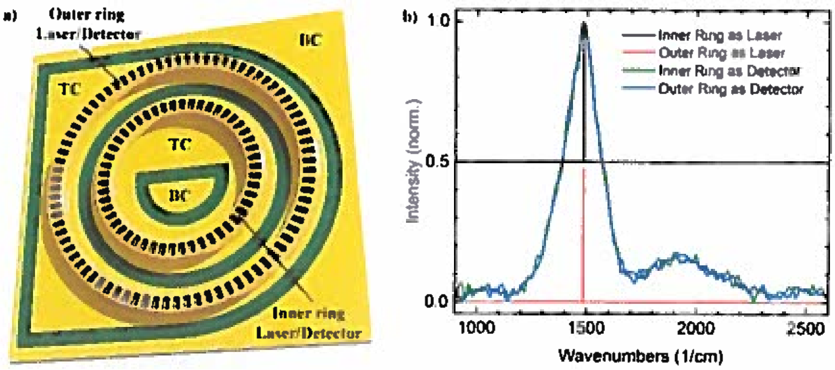

Figure 2: (a) Sketch of the vertically emitting and detecting remote sensor with top (TC) and bottom (BC) contacts for each ring. (b) Laser and detector spectra of both rings.

wavelength overlap is shown in Fig. 2(b). In the corresponding sensing setup one of the rings is emitting laser light at the designed wavelength. The light travels through the gas cell and is back-reflected by a flat gold mirror before it propagates back the initial path. On the sensor chip it is then detected by the other ring. This sensor setup is schematically illustrated in Fig. 3. For this sensor concept the length of the light-analyte interaction region is given by the position of the mirror and can be adapted to the specific application. Our sensor can be operated in two configurations: (i) Inner ring as laser and outer ring as detector. (ii) Outer ring as laser and inner ring as detector. In addition, both rings emit at a different wavelength, which provides room temperature lasing and detection of two wavelengths monolithically integrated on the same chip.

Figure 3: Remote gas sensing setup. Light is emitted and detector at the sensor chip by the two concentric ring QCLDs.

RESULTS AND CONCLUSION

Proof-of-principle sensing experiments were performed with isobutene and isobutane as analyte gases. Our sensor shows good performance within a wide concentration range from 0-20% with a limit-of-detection of 400ppm utilizing a 10cm gas cell resulting in a total absorption path of 20cm. These direct absorption measurements are in good agreement with the Lambert-Beer law. In conclusion, we introduce a compact remote sensor concept based on bi-functional and commutable QCLDs and present proof-of-principle gas measurements demonstrating the high sensitivity of the sensor.

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REFERENCES

[1] *M. Vitiello, et. al., Opt. Express 23, 5167 (2015)*
[2] *B. Schwarz, et. al., Nat. Comm. 5, 4085 (2015)*
[3] *A. Harrer, et. al., Sci. Rep. 6, 21795 (2016)*
[4] *R. Szedlak, et. al., Sci. Rep. 5, 16668 (2015)*

KEY WORDS
Quantum cascade laser; quantum cascade detector; sensor; gas sensing; mid-infrared; spectroscopy;