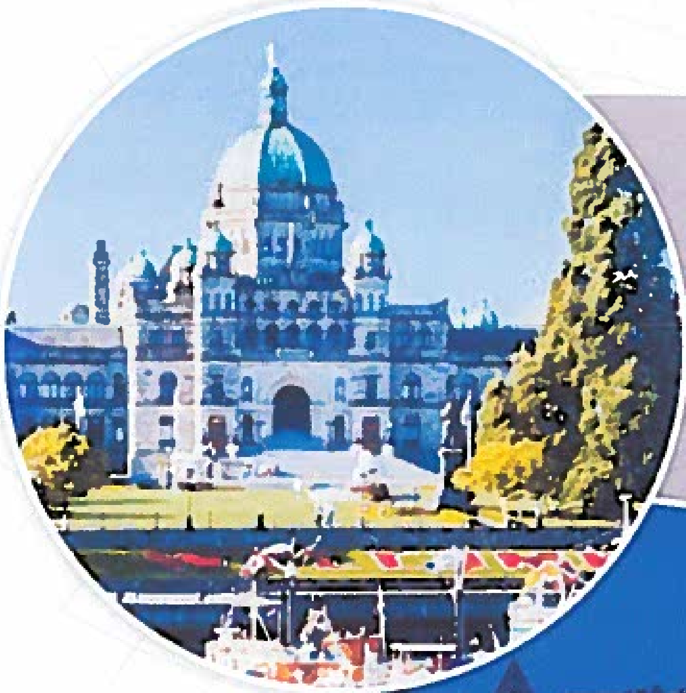
9th International Conference on

ADVANCED VIBRATIONAL SPECTROSCOPY

ICAVS 9



Victoria, BC

July 11 – 16, 2017

Victoria Conference Centre

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Code	Time	Event
31.5	11:45 – 12:00	***Photonic Gas Sensing with Commutable Laser and Detector on the same Chip*** Rolf Szedlak[1], Andreas Harrer[1], Benedikt Schwarz[1], Martin Holzbauer[1], Johannes Waclawek[1], Donald MacFarland[1], Tobias Zederbauer[1], Hermann Detz[1], Aaron Andrews[1], Werner Schrenk[1], Bernhard Lendl[1], Gottfried Strasser[1] *[1]TU Wien*
32	*Oak Bay 2 Room*	**PARALLEL SESSION 32 – PARTICLES AND PROCESSES IN PHARMACEUTICAL AND BIOLOGICAL SYSTEMS** *Chair:* Keith Gordon
32.1	10:30 – 10:50	***Evolution of process Raman spectroscopy: from feasibility to control*** Karen Esmonde-White[1], Maryann Cuellar[1], Sean Gilliam[1], Carsten Uerpmann[2], Herve Lucas[2], Bruno Lenain[2], Carsten Uerpmann[1], David Strachan[1], Ian Lewis[1] *[1]Kaiser Optical Systems Inc., [2]Kaiser Optical Systems SARL*
32.2	10:50 – 11:10	***Enhanced Particle Analysis: Combining Micro-Spectroscopic Techniques with Complementary Image Based Characterization Methods*** Jonas Thygesen[1] *[1]Novo Nordisk Pharmatech*
32.3	11:10 – 11:30	***Exploring the Nanoparticle Eco-Corona Formation and Impact with Surface-Enhanced Raman Spectroscopy*** Ryo Sekine[1], Marianne Matzke[1], Iseult Lynch[2], Claus Svendsen[1] *[1]Centre for Ecology and Hydrology, [2]University of Birmingham*
32.4	11:30 – 11:45	***Investigating the uptake and response of hMSC cells exposed to Falcarindiol*** Richard Cowie[1], Jes Linnet[1], Dennis Høj[1], Anders Walther[1], Jakob Jepsen[1], Rime El-Houri[1], Eva Christensen[1], Morten Andersen[1], Martin Hedegaard[1] *[1]University of Southern Denmark*
32.5	11:45 – 12:00	***Contribution of Ribonucleic Acid (RNA) to the FTIR spectrum of eukaryotic cells*** Lisa Vaccari[1], Paolo Zucchiatti[1], Sasa Kenig[1], Fulvio Billè[1], George Kourousias[1], Diana Bedolla[1], Ramiro Mendoza-Maldonado[1] *[1]Elettra - Sincrotrone Trieste ScpA*
	12:00 – 13:30	**Lunch**
33	*Lecture Theatre*	**PARALLEL SESSION 33 – BIOMEDICAL SPECTROSCOPY 3** *Chair:* Boris Mizaikoff
33.1	13:30 – 13:50	***Vibrational spectroscopy for screening and detection of early esophageal cancer*** Hugh Barr[1], Oliver Old[1], Gavin Lloyd[1], Catherine Kendall[1], Nick Stone[1] *[1]Gloucestershire Royal Hospital*
33.2	13:50 – 14:10	***Infrared Spectral Histopathology Using (H&E) Stained Glass Slides: One Less Barrier to Clinical Translation.*** Peter Gardner[1], Michael Pilling[1], Alex Henderson[2], Jonathan Shanks[3], Michael Brown[2], Noel Clarke[1] *[1]University of Manchester, [2]The Christie Hospital, [3]Christie Hospital*
33.3	14:10 – 14:30	***Real-time In Vivo Tissue Raman Spectroscopy for Endoscopic Lung Cancer Detection*** Haishan Zeng[1], Hanna McGregor[1], Michael Short[1], Annette McWilliams[1], Tawimas Shaipanich[1], Diana Ionescu[2], Jianhua Zhao[1], Wenbo Wang[1], Guannan Chen[1], Stephen Lam[1] *[1]BC Cancer Agency Research Centre, [2]University of British Columbia*

Photonic Gas Sensing with Commutable Laser and Detector on the same Chip

Rolf Szedlak[1,*], Andreas Harrer[1], Benedikt Schwarz[1], Martin Holzbauer[1], Johannes P. Waclawek[2], Donald MacFarland[1], Tobias Zederbauer[1], Hermann Detz[3], Aaron M. Andrews[1], Werner Schrenk[1], Bernhard Lendl[2], Gottfried Strasser[1]

[1]*Institute of Solid State Electronics & Center for Micro- and Nanostructures, TU Wien, Floragasse 7, 1040 Vienna, Austria*
[2]*Institute of Chemical Technologies and Analytics, TU Wien, Getreidemarkt 9/164 AC, 1060 Vienna, Austria*
[2]*Austrian Academy of Sciences, Dr. Ignaz Seipel-Platz 2, 1010 Vienna, Austria*
[*]*rolf.szedlak@tuwien.ac.at*

Mid-infrared spectroscopy is a powerful and reliable tool for numerous chemical sensing applications in a variety of fields including environmental monitoring, industrial analytics and medicine. Quantum cascade lasers (QCLs) [1] provide tailorable emission characteristics and are therefore widely used in spectroscopic sensing. The typical setup configuration consists of a light emitter, a light-analyte interaction region and a separate external detector, e.g. an MCT detector. Here, we demonstrate a novel sensing concept based on bi-functional quantum cascade heterostructures [2]. By monolithically integrating laser and detector on a single chip, we realize a compact and efficient surface-active sensor which enables a crucial miniaturization of sensing devices and could lead to versatile hand-held remote sensors.

Our sensor [3] consists of two concentric ring quantum cascade laser/detectors (QCLDs). Each ring possesses a second order DFB grating etched into the ring waveguide. This grating enables vertical light emission *and* at the same time detection of normal incident light, i.e. both rings can be used as laser *and* as detector. A sketch of our sensor is depicted in Fig. 1(a).

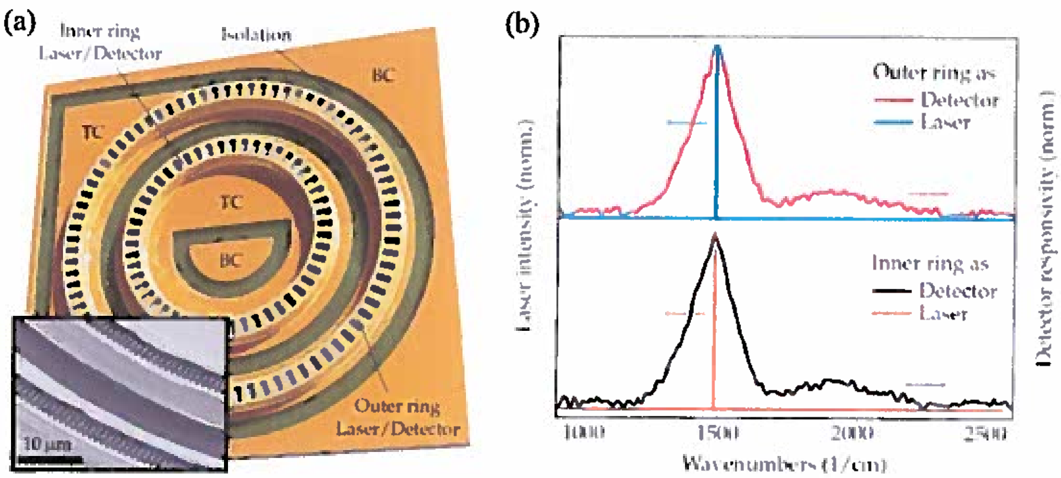

Figure 1. (a) Sketch of the sensor with two monolithic ring laser/detectors. Inset: SEM image of the grating. (b) Emission and detection spectra of both rings. Source: [3]

Utilization of bi-functional heterostructures allows for a precise matching of emission and detection wavelength. The spectral overlap at around 1500/cm between laser and detector is shown in Fig. 1(b). Hence, two operation modes are feasible: (i) Inner ring as detector and outer ring as laser. (ii) Outer ring as detector and inner ring as laser. Different DFB grating periods provide laser emission from the two rings at two slightly varying wavelengths. Based on this sensor concept proof-of-concept gas sensing experiments of isobutane and isobutene were performed with the setup indicated in Fig. 2(a). The light is emitted from one ring on the sensor chip, collimated by a lens and propagates through the gas cell. At the flat gold mirror the light is back-reflected and takes the same path back to the sensor chip where it is detected by the other ring. As shown in Fig. 2(b) our experimental results show a good agreement with Beer-Lambert's law. A limit of detection of 400ppm is reached.

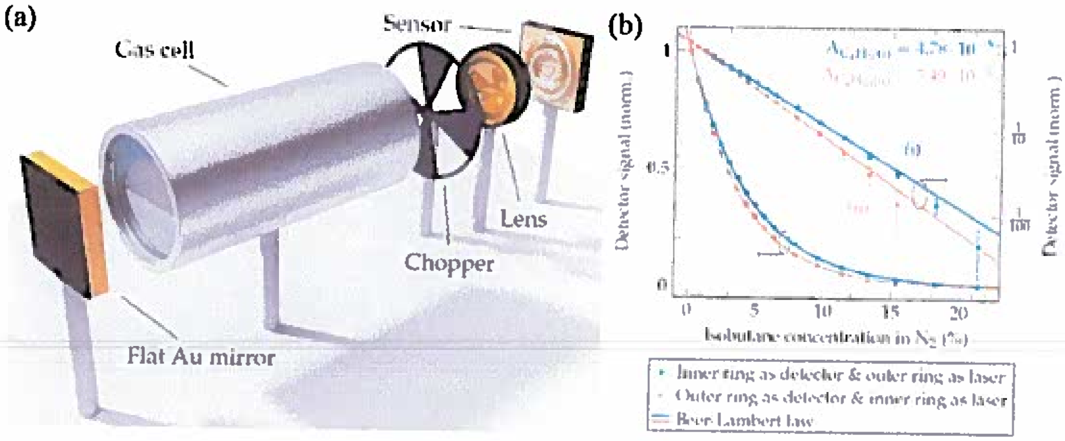

Figure 2. (a) Sensing setup. (b) Experimentally obtained transmittance of isobutane as a function of the gas concentration. Source: [3]

In conclusion, we introduce a compact and versatile remote sensor based on quantum cascade laser and detectors integrated on the same chip. Proof-of-concept gas measurements demonstrate the working principle and sensitivity of the sensor.

[1] J. Faist, et al., Science 264, 553-556 (1994).
[2] B. Schwarz, et al., Nature Communications 5, 4085 (2014).
[3] R. Szedlak, et al. ACS Photonics 3, 1794-1898 (2016).