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nanoFIS 2017

3rd International Conference

Functional Integrated *nano* Systems

CONFERENCE DOCUMENTATION

22 - 24 November 2017
University of Graz (AULA)
Universitätsplatz 3, 8010 Graz /Austria

Organised by:

MCL MATERIALS CENTER

Program, 23 November 2017

SMART MANUFACTURING PROCESSES

14.00 Fast turn-around mask-less Lithography using thermal Probes
Urs Duerig, SwissLitho AG, Zurich (Switzerland)

14.15 Innovative Processes and Materials for LED Packaging
Georg Jakopic, JOANNEUM RESEARCH Forschungsgesellschaft mbH, Institute for Surface Technologies and Photonics, Weiz (Austria)

14.30 Metal peroxide as combustion Promoter in CMOS compatible Thick Film Gas Sensor Fabrication
Olena Yurchenko, University of Freiburg, Department of Microsystems Engineering – IMTEK (Germany)

14.45 Nanoimprint Replication of T-shaped Nanostructures
Anja Haase, JOANNEUM RESEARCH Forschungsgesellschaft mbH, Institute for Materials, Weiz (Austria)

15.00 Analysis of direct-write Gold Nanostructure-Purification with nanomechanical Scanning Absorption Microscopy
Mostafa Moonir Shawrav, Vienna University of Technology, Institute of Sensors & Actuator Systems, Vienna (Austria)

SYSTEM INTEGRATION & PACKAGING

16.00 Low-Temperature 3D Integration Processes for Advanced Sensor Systems (Invited Lecture)
Josef Weber, Fraunhofer Research Institution for Microsystems and Solid State Technologies, Munich (Germany)

16.30 Selective over-molding of a CMOS TSV Wafer with the flexible 3D Integration of Components and Sensors
Ton van Weelden, Boschman Technologies, Duiven (Netherlands)

16.45 Rapid Manufacturing of interposer/redistribution Layer via Inkjet Nanoparticle Printing
Matic Krivec, CTR Carinthian Tech Research AG, Smart Systems, Villach (Austria)

17.00 MSP – Multi Sensor Platform for Smart Building Management
Anton Köck, Materials Center Leoben Forschung GmbH, Microelectronics (Austria)

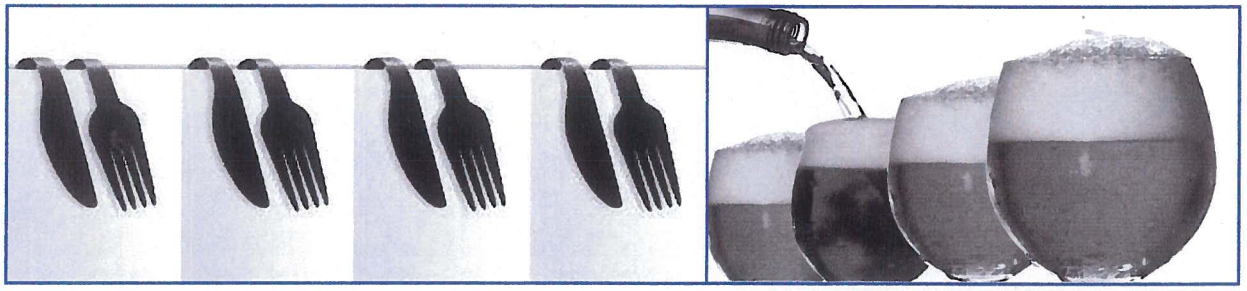
17.15 Monolithic Integration of a Quantum Cascade System (Invited Lecture)
Gottfried Strasser, Vienna University of Technology, Institute of Solid State Electronics, Center for Micro- and Nanostructures (Austria)

– 17.45 End of Technical Sessions –

18.00 **- Guided Historic City Walk –**

(starts at congress location and ends up at the evening event location)

19.30 EVENING DISCUSSION - CONGRESS DINNER



SYSTEM INTEGRATION & PACKAGING

Monolithic Integration of a Quantum Cascade System

Gottfried Strasser[1,2,*]

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ABSTRACT: Optical sensors for mid-infrared spectroscopy are used widely in environmental and industrial process control and/or 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 developed and improved a sensor concept based on a bi-functional quantum cascade heterostructure, for which the differentiation between laser and detector is eliminated. This enables mutual commutation of laser and detector, simplifies remote sensing setups and allows crucial miniaturization of sensing devices for further integration.

Liquid sensing utilizing bi-functional quantum cascade lasers/detectors (QCLDs) can be realized on a single chip [1]. A QCL active region design with an additional detection capability at the laser emission wavelength allows a straightforward integration, where different areas on, the chip are used for lasers, and others for detectors.

The performance of such bi-functional designs has been optimized [2] to reach a similar laser performance as conventional QCLs, allowing for high duty cycle operation at room-temperature.

Special emphasis on the performance optimization of QC detectors lead to record values in single period QC devices [3].

Sensing liquids utilizes surface plasmon polaritons to allow a strong interaction within a short distance. Different distributed-feedback-laser/waveguide/detector units can be combined on a single chip, to use the inherent selectivity of the mid-infrared region.

Typical analyte interaction lengths for gas sensing are in the range of tens of centimeters or more and exceed the common semiconductor chip sizes. Our gas sensing approach incorporates surface-active lasers and detectors [4]. The latest demonstrators consist of two concentric ring QCLDs with second order distributed feedback (DFB) gratings on top of the waveguides. These DFB gratings facilitate vertical light emission [5] and detection in the biased lasing and unbiased detector configuration, respectively. The two rings emit at two different wavelengths, which provides room temperature lasing and detection of two wavelengths monolithically integrated on the same chip.

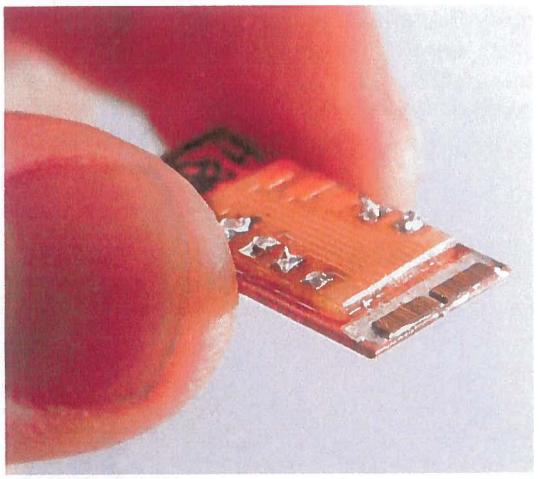

Figure 1: Bars of QC laser and detector arrays bonded and contacted on a submount for device characterization.

REFERENCES:

[1] B. Schwarz, D. Ristanic, P. Reininger, T. Zederbauer, D.C. MacFarland, H. Detz, A.M. Andrews, W. Schrenk, G. Strasser, "High performance bi-functional quantum cascade laser and detector", Appl. Phys. Lett. 107(7), 071104/1-3 (2015)
[2] B. Schwarz, C. Wang, L. Missaggia, T. Mansuripur, P. Chevalier, M. Connors, D. McNulty, J. Cederberg, G. Strasser, F. Capasso, "Watt-level continuous-wave emission from a bi-functional quantum cascade laser/detector", ACS Photonics 4(5), 1225-1231 (2017)
[3] B. Schwarz, P. Reininger, A. Harrer, D. MacFarland, H. Detz, A. Andrews, W. Schrenk, G. Strasser, "The limit of quantum cascade detectors: A single period device", Appl. Phys. Lett. 111, 061107 (2017)
[4] A. Harrer, R. Szedlak, B. Schwarz, H. Moser, T. Zederbauer, D. MacFarland, H. Detz, A.M. Andrews, W. Schrenk, B. Lendl, G. Strasser, "Mid-infrared surface transmitting and detecting quantum cascade device for gas-sensing applications", Scientific Reports 6, 21795 (2016)
[5] R. Szedlak, A. Harrer, M. Holzbauer, B. Schwarz, J. Waclawek, D. MacFarland, T. Zederbauer, H. Detz, A.M. Andrews, W. Schrenk, B. Lendl, G. Strasser, "Remote sensing with commutable monolithic laser and detector", ACS Photonics 3(10), 1794–1798 (2016)