SWISS PHOTONICS

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Optical Gas Sensing

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Dr. Christoph S. Harder

President Swissphotonics, Schindellegi SZ
harder@swissphotonics.net | www.swissphotonics.net

Dr. Christoph S. Harder received the Electrical Engineering Diploma from the ETH in 1979 and the Master and PhD in Electrical Engineering in 1980 and 1983 from Caltech, Pasadena, USA. He is co-founder of the IBM Zurich Laser Diode Enterprise which pioneered the first 980nm high power pump laser for telecom optical amplifiers.
He has been managing during the last few years the high power laser diode R&D effort in Zurich expanding, working closely with a multitude of customers, the product range into 14xx pumps as well as 808 and 9xx multimode pumps for industrial applications. He has published more than 100 papers and 20 patents and has held a variety of staff and management positions at ETH, Caltech, IBM, Uniphase, JDS Uniphase, Nortel and Bookham.

Welcome

Prof. Dr. Lukas Novotny

Photonics Laboratory ETH, Zürich
lnovotny@ethz.ch | www.photonics.ethz.ch

Dr. Lukas Novotny is a Professor of Photonics at ETH. His research focuses on nanophotonics. He is the author of *Principles of Nano-Optics*, the holder of six patents, and a Fellow of the Optical Society of America and the American Association for the Advancement of Science.

Introduction

Prof. Dr. Markus W. Sigrist

Inst. Quantum Electronics, IQE ETH, Zürich
sigristm@phys.ethz.ch | www.iqe.phys.ethz.ch

Dr. Markus Sigrist became a Professor at ETH in 1996 and headed the Laser Spectroscopy and Sensing laboratory until his retirement in October 2013. His research focused on IR laser spectroscopy for environmental, industrial, forensic and medical sensing. He published numerous journal papers, several book chapters and books. He is a member of various professional societies and a Fellow and Traveling Lecturer of OSA.

Keynote: Overview over optical gas sensing methods
This keynote is emphasizing the mid-infrared (fingerprint) region with strong and specific molecular absorptions. The basic principles and architecture of laser-based systems are discussed. The main features (sensitivity, specificity, multi-component capability, spectral analysis) and perspectives are illustrated with numerous examples including environmental, industrial and medical sensing applications.

Dr. Bert Willing

Manager R&D at Rüeger SA, Crissier VD
b.willing@rueger.com | www.rueger.com

Physics gradute of TU Braunschweig and PhD in physics at the MPI für Festkörperforschung Grenoble/RU Nijmegen. Post-doc at EPFL working on thin-film infrared sensors; founder and CEO of IR Microsystems SA (industrial laser gas sensor), followed by a trade sale to Leister/Axteris. Consultant for start-up sensor companies, presently Manager R&D at Rüeger SA (thermal sensors).

Industrial view: Optical gas sensing in Switzerland
A perspective view – from hand-made systems to high-volume sensors: Where is the sweet spot? What does the customer need, and why ? Where could a start-up fit in, what could be pit-falls? Some examples of long-standing customer requests will be discussed.

Dr. Emanuel Lörtscher

Research Staff Member IBM Research Laboratory, Rüschlikon ZH
eml@zurich.ibm.com | www.zurich.ibm.com

Dr. Emanuel Lörtscher is a Research Staff Member in the Advanced Micro Integration (AMI) group at IBM Research – Zurich. He received a diploma in physics from the ETH in 2003, and a PhD from the University of Basel in 2006. His research is focused on nanoscale optics and electronics with applications in molecular electronics, nanomechanics, plasmonics and advanced micro- and nanointegration.

Plasmonic gas sensing - IR sensing of the future?
Plasmonic structures with gaps in the 1nm-range provide large field enhancements applicable for sensing down to the single-molecule level. Optical antennas were fabricated with unprecedented resolution to probe single molecules spectroscopically. Due to the junction's large field gradients, optical selection rules are altered and Raman emission from infrared modes is achieved, representing a novel and more comprehensive spectroscopy platform.

Dr. Markus Rossi

CIO Heptagon Oy, Rüschlikon ZH
markus.rossi@hptg.com | www.hptg.com

Formerly head of CSEM Zurich Replicated Micro-Optical Elements, Markus became CTO of Heptagon after CSEM's microoptics division was acquired by Heptagon in 2000. He is an expert on fabricating diffractive and refractive micro-optic components for industrial applications in the European and US markets. Markus holds a PhD from the University of Neuchâtel, Switzerland and a master's degree in physics from ETH.

High-volume, low cost imaging optics for the visible … and the IR?
Portable devices like smartphones are continuing to drive optical sensing components (imaging cameras, depth sensing) to smaller form factors and higher performance. The related design and manufacturing technologies - ranging from wafer-level optics to wafer-level packing - start to be applied in a wider range of applications, such as thermal imaging and miniaturized spectrometers.

Dr. Antoine Muller

CEO Alpes Lasers SA, Neuchâtel
antoine.muller@alpeslasers.ch | www.alpeslasers.ch

Dr. Antoine Muller is CEO of Alpes Lasers since 1998 and co-founder of the company, he was previously a Post doc at the University of Neuchâtel, at Boston University and NIST Gaithersburg and at the University of Geneva where he graduated. He was born in Geneva in 1964. Before to focus on Quantum Cascade Lasers (QCLs) he worked on quantum cryptography.

QCL MIR light sources
QCLs are semiconductor light sources of choice for applications in the mid-infrared such as chemical sensing. The available specification and performance trade offs are discussed. The development of watt-level devices is reported. Broad spectral reach devices using electrical or mechanical single mode tuning or comb are shown.

Dr. Ferdinand Felder

CEO Phocone AG, Camlin Technologies Switzerland, Zürich
f.felder@camlintechnologies.com | www.camlintechnologies.com

After his PhD in physics Dr. Ferdinand Felder co-founded a spin-out from ETH Zurich in 2011. The company was supported by a ETH Pioneer Fellowship and multiple CTI projects. It is now part of the Camlin Group of companies, focussing on the further research and development of the laser technology. Ferdinand also holds a MAS in technology management from ETH.

Tunable VECSELs for MIR optical gas sensing
Camlin Technologies CH develops, produces, and implements novel laser modules for the precise and fast measurement of gas mixtures. The VECSEL technology allows the broad tuning of the single emission wavelength and thus a scan of a broad spectrum. Focus applications are the analysis hydrocarbon gas mixtures, e.g. safety and quality of natural gases.

Prof. Dr. Peter Seitz

Head, Hamamatsu Photonics Innovation Center Europe
Adjunct Professor of Optoelectronics, EPFL
Deputy Managing Director, Innovation and Entrepreneurship Lab (ieLab), ETH
peter.seitz@sl.ethz.ch | sales.hamamatsu.com

Dr. Peter Seitz studied physics at ETH, receiving his PhD from ETH in 1984. He worked for RCA Research Labs, General Electric, PSI, CSEM, the University of Neuchâtel, EPFL and ETH.
He authored 200 publications in the fields of applied optics, semiconductor image sensing, optical metrology and MedTech. He holds 50 patents, and he has won 20 national and international awards. He is a member of the Executive Board of Photonics21, chairing the workgroup on sensing, metrology and security.

Solid-state IR photosensing
A comprehensive taxonomy of semiconductor-based infrared radiation detectors is given, covering quantum detection as well as thermal infrared sensing principles. Particular emphasis is put on low-cost IR detection techniques based on industry-standard CMOS/CCD processes, such as Quantum Dots on CMOS chips, as well as free charge carrier absorption and inter-subband transitions in silicon.

Dr. Andreas Hugi

Co-Founder and Manager IRsweep GmbH, Zürich
hugia@ethz.ch | www.irsweep.com

Prior to co-founding IRsweep, Andreas received his PhD on single-mode and comb operation of broadband QCLs in 2013 under the supervision of Jérôme Faist. He received his master of science in micro- and nanotechnology in 2007. Among others, Andreas was awarded the ETH Medal for an outstanding doctoral thesis and the Omega student award for his master thesis.

QCL frequency combs for high-performance optical gas sensing
We develop a mid-IR spectroscopy platform for industrial applications based on semiconductor QCL frequency combs. The platform's key features will be an unmatched combination of bandwidth (100 cm^{-1}), resolution (100 kHz), speed (100 µs), size (semiconductor laser based) and robustness (no moving parts). This allows next generation real-time industrial process observation where the combination of speed and bandwidth is essential.

Dr. Lukas Emmenegger

Head Laboratory, Empa, Dübendorf ZH
lukas.emmenegger@empa.ch | www.empa.ch

Dr. Lukas Emmenegger is Head of the Laboratory for Air Pollution / Environmental Technology at Empa and group leader for applied laser spectroscopy. He studied Natural Sciences and Analytics at the Universities of Fribourg and Geneva, and received his PhD from ETH. Besides his research activities, Lukas Emmenegger has years of experiences in engineering and teaching within private and governmental institutions.

MIR Spectroscopy for environmental applications
Mid-IR spectroscopy is a powerful tool for qualitative and quantitative gas sensing. The commercial availability of room temperature, distributed feedback quantum cascade lasers (DFB-QCL) has been a major step fostering the development of mobile, selective and sensitive gas analyzers. Many examples illustrate both selectivity, including the detection of stable isotopes, and sensitivity down to the ppt range.

Dr. Matthias Kutter

CEO at Eco Physics AG, Dürnten ZH
matthias.kutter@ecophysics.com | www.ecophysics.com

1975 Dipl. chem. ETH
1982 Dr. sc. techn. ETH Zürich
1983 Marketing bei der AMA

Product Manager bei Mettler-Toledo (Schweiz) GmbH
Product Manager bei Tecan AG
Mitgründer der Firma ECO PHYSICS AG durch Management Buy-Out

Photoacoustic Spectroscopy using a QCL
The photoacoustic spectroscopy using a QCL as a light source is a solid foundation
for a gas sensing analyzer. The modular constructing of the analyzer is shown as well as some potential applications like emission and immission monitoring and applications in semiconductor industries.

Roland Koch

CEO of Wilco AG, Wohlen AG
roland.koch@wilco.com | www.wilco.com

Roland Koch graduated as Electrical Engineer from Technical University in Basel. In 1994 he joined Wilco's Controls department, responsible for all control system hardware. He started to build up the validation department and was responsible for the major projects in the pharmaceutical business. In 2002 he started his responsibility for the development of spectroscopic systems in house Wilco. He was the Head of the departments Controls, Validation and Projects and became Assistant General Manager in January 2013.
Since July 1, 2014 he is CEO of Wilco AG.

Optical gas sensing for leak detection
Optical gas sensing offers a wide range of high sensitive and high speed testing technologies for leak testing of containers in the industry. A laser based spectrometer is used to detect propellants of leaking Aerosol cans, using a machine with a testing speed of 500 cans per minute.

Dr. Thomas A. Paul

Group Leader Sensor Tech., ABB Switzerland Ltd., Baden-Dättwil AG
thomas.paul@ch.abb.com| new.abb.com

Dr. Thomas Paul received his Master in Chemistry from University College London. He continued his studies in the field of physical chemistry at ETH and was awarded his PhD in the field of vacuum-ultraviolet spectroscopy. He joined ABB Corporate Research in 2009 focusing on novel gas-monitoring technologies and investigations on environmentally benign dielectric insulation gases. Since 2014 he is group leader of the Sensor Technologies group.

Optical technologies in the power industry: monitoring and diagnosis of gas-insulated electrical switchgear
Transmission and distribution of electricity requires switchgear such as circuit breakers in order to control the grid. For high-voltage switchgear, SF_6 gas is used to insulate conductors and to interrupt currents. Optical technologies are employed for a variety of applications relating to SF_6, ranging from leakage detection to composition monitoring.

Dr. Ross Stanley

Section Head CSEM SA, Neuchâtel
ross.stanley@csem.ch| www.csem.ch

PhD(1991) in Physics , TCD, Ireland
Section Head, CSEM SA, Neuchâtel, Switzerland, responsible for optical MEMS, IR and plasmonics development projects at the CSEM SA
Current activities: optical engineering, applied plasmonics, tunable MEMS gratings for Mid-IR lasers, novel IR emitters, gas sensing.
Session Chair of SPIE Photonics West since 2006
Author of > 80 refereed publications.

Tunable optical gas sensors using MEMS devices
In this talk, we will present results on a range of MEMS based devices developed for gas sensing. First, tunable MEMS gratings for tunable quantum cascade lasers at 10 microns. Second, MEMS based spectral filters that can be used alone or in cavity configurations. Third, nanoporous layers for indirect detection of gases such as O_2 and CO_2.

Dr. Thomas Hessler

Direktor Axetris AG, Kaegiswil OW
thomas.hessler@axetris.com | www.axetris.com

Dr. Thomas Hessler obtained his Physics degree at Constance University and his PhD degree from University of Neuchâtel in applied optics. He started with Leister in Business Development and is now responsible for Axetris, a company of the Leister group, which is a leading OEM supplier of micro-optics and gas sensing modules.

Moderator panel disscusion: Roadmap for ubiquitous optical gas sensing

SWISS PHOTONICS

Managing director
Dr. Christian Bosshard
bosshard@swissphotonics.net
Telefon +41 61 690 60 40

President
Dr. Christoph Harder
harder@swissphotonics.net
Telefon +41 79 219 90 51

Internet
www.swissphotonics.net