



Deliverable N° D 4.6

iCspec workshop

Project Identifier	636930
Project Acronym	iCspec
Project Title	in-line Cascade laser spectrometer for process control
Instrument	RIA
Topic	SPIRE 1 - 2014: Integrated Process Control
Start date of Project	01/04/2015
Duration	3 years
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Actual Submission Date	28/02/2018
Lead Partner	WRUT
Other Partners	All

Short description:

The consortium organized a workshop on a subject of laser-based gas sensing. This was the fourth of the MIRSENS Workshop series (International workshop on opportunities and challenges in mid-infrared laser-based gas sensing - <http://mirsensconference.org/>) held in Wrocław, Poland, May 15-17, 2017. Its scientific programme contained 10 invited talks given by renowned experts, 33 contributed talks and 15 posters, covering all the related subjects and representing all the key players in this field from both academia and industry. In total, 87 scientists, engineers, application managers from 16 countries participated in Mirsens 4, representing a broad spectrum from photonic device development, through physics and fabrication of devices, to applied laser spectroscopy in various branches, a perfect audience to disseminate the iCspec results in an efficient way.

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Introduction

An important objective of the iCspec Project was to disseminate the gained new scientific knowledge and information about the project achievements efficiently and effectively. The goal was to stimulate research and the overall advancement of the field, thereby ensuring that further development and exploitation in laser and sensor technology is supported by the scientists and engineers who are experts in the field. The consortium has focused on dissemination ways allowing spreading the awareness on the results obtained in both research and industrial areas, promoting the synergy between industry and academia.

One of the main dissemination forums planned by the iCspec consortium was to organize a workshop in a subject related to the core project activity, which is laser-based gas sensing. As some of the Project partners were previously involved in a series of successful MIRSENS workshops (initiated by WRUT, NP and UWUERZ in 2010), iCspec consortium decided to use this formula and organize MIRSENS 4. The workshop was hosted by WRUT (which took also care of the local organization) and was held in Wrocław, Poland, May 15-17, 2017. There was also created a dedicated workshop website <http://mirsensconference.org/> (front page of which is shown below), on which the Workshop Programme as well as the Book of Abstracts are also available.



The image shows the homepage of the mi4sens website. The header includes the mi4sens logo and a navigation menu with links: About, Committees, Invited Speakers, Dates, Registration, Program, Venue, Excursions, Gallery, and Contact. The main content area features the mi4sens logo and the text: "International workshop on opportunities and challenges in mid-infrared laser-based gas sensing". Below this, it states "Wrocław, Poland" and "15 - 17 May 2017". On the right side, there is an "Organisers" section with the text: "Organised by the iCspec Project consortium of European Union's Horizon 2020 SPIRE Programme". Below this, there are logos for iCspec, SPIRE, and the Horizon 2020 Framework Programme of the European Union.

Information about the workshop

Mirsens 4 Workshop organized by iCspec continued the already established tradition of the previous Mirsens workshops which took place in 2010 and 2012 in Wrocław, and in 2015 in Würzburg. Its main idea is to promote an informal interaction between academic and industrial institutions active in MIR research and to address scientific and technological challenges and the associated application prospects. The Mirsens 4 Workshop covered all the issues related to developments of modern MIR materials, technologies devices, sensing schemes and applications, including especially those related to process control.

The Workshop topics included in particular:



- Semiconductor materials and structures for the mid-infrared
- Recent progress in MIR laser sources
- Laser-based gas sensing and the related spectroscopic techniques
- New application prospects

The Workshop attracted 87 participants from 16 countries: Austria, Belgium, China, Denmark, Germany, Finland, France, Italy, Lithuania, Norway, Northern Ireland, Poland, Switzerland, Taiwan, the United Kingdom and the United States. The audience represented scientists, engineers, application managers, representing a broad spectrum from photonic device development, through physics and fabrication of devices, to applied laser spectroscopy in various branches, a perfect audience to disseminate the iCspec results in an efficient way, and conduct informal and productive discussions in a friendly atmosphere. The organizers managed to encourage a number of young scientists to attend the meeting and an important fraction among the participants constituted students and PhD students, which was also an indicator of a scientifically attractive and up-to-date programme.

The scientific programme contained 10 invited talks given by highly renowned experts in these fields, plus 33 contributed talks and 15 posters, representing many institutions from both academia and industry. All the key-player institutions in the field of optical gas sensing have been represented. List of the invited talks is shown below:

- 1. Markus-Christian Amann**
Technical University Munich, Germany
“Single mode tunable VCLSEs for the 2-4 μm wavelength range”
- 2. Maciej Bugajski**
Institute of Electron Technology, Warsaw, Poland
“Strain-compensated AlInAs/InGaAs InP quantum cascade lasers”
- 3. Rui-Feng Kan**
Chinese Academy of Sciences, China
“MIR TDLAS technology for industrial emission and environmental monitoring”
- 4. Peter Kaspersen**
Norsk Elektro Optikk, Norway
“Laser-based spectroscopy – A success story?”
- 5. Johannes Koeth**
Nanoplus GmbH, Germany
“Specialized laser sources for sensing in the MIR”
- 6. Barry McManus**
Aerodyne Research Inc., USA
“Recent progress in trace gas instrument development at Aerodyne Research Inc.”
- 7. Jerry Meyer**
Naval Research Laboratory, USA
“Advances in interband cascade lasers and LEDs”
- 8. Józef Piotrowski**
Vigo System, Poland
“Recent progress in development of mid-IR detection modules for gas analyzers”
- 9. Gerard Wysocki**
Princeton University, USA
“Interband cascade laser-based dual-comb multi-heterodyne spectroscopy of small and large molecules”
- 10. Rui Yang**
University of Oklahoma, USA
“Recent progress in interband cascade devices”



In addition, there has been established an exhibition which involved 9 companies working in the areas of laser and sensing devices and systems (including two representatives of iCspec: NP and AIR) and presenting their products. The event was especially important from the point of view of efficient dissemination of the information on iCspec Project and its achievements worldwide. The Project coordinator opened the Workshop with a dedicated presentation overviewing iCspec. There was also invited talk by NP partner presenting the results obtained within iCspec, as well as several contributed talks and posters from other partners. A few exemplary photographs taken during the Mirsens 4 workshop taken at various occasions are presented below and show the atmosphere of the event. More pictures can be found at the website under: <http://mirsensconference.org/gallery.php>.





Full workshop programme

Monday - 15.05.2017						
8:00	Reception desk open					
9:00	9:10	Opening Address				
9:10	9:40	Rainer Strzoda	Siemens AG	Germany	Opening presentation	In-line cascade laser spectrometer for process control - iCspec project
SESSION: Sensing systems I						
9:40	10:20	Peter Kaspersen	Norsk Elektro Optikk	Norway	Invited	Laser-based spectroscopy - A success story?
10:20	11:00	Gerard Wysocki	Princeton University	USA	Invited	Interband cascade laser-based dual-comb multi-heterodyne spectroscopy of small and large molecules
11:00	11:20	Coffee break				
SESSION: Sensing systems II						
11:20	11:40	Frank Tittel	Rice University	USA	Contributed	Recent Advances and Applications of Mid-infrared Cavity and Quartz Enhanced Photoacoustic Spectroscopy
11:40	12:00	Paweł Kluczyński	Airoptic	Poland	Contributed	Multi-component Mid-IR tunable laser analyzers for process control
12:00	12:20	Karol Krzempek	Wroclaw University of Science and Technology	Poland	Contributed	Photothermal spectroscopy of NO at 5.2 μm using Quantum Cascade Laser and near-infrared heterodyne-based detection
12:20	12:40	Johannes Waclawek	Vienna University of Technology	Austria	Contributed	2f-Wavelength Modulation Fabry-Perot Photothermal Interferometry
12:40	13:00	Arkadiusz Hudzikowski	Wroclaw University of Science and Technology	Poland	Contributed	Compact, Low Power Mid-infrared Methane Isotopes ¹³ CH ₄ and ¹² CH ₄ Sensor Using Room-temperature CW Interband Cascade Laser (ICL)
13:00	14:00	Lunch break				
13:00	14:00	Lunch break				
SESSION: Detectors & sources in MIR I						
14:00	14:40	Markus C. Amann	Technical University Munich	Germany	Invited	Single-mode tunable VCSELs for the 2-4 μm wavelength range
14:40	15:20	Józef Piotrowski	Vigo System	Poland	Invited	Recent progress in development of mid-IR detection modules for gas analyzers
15:20	15:40	Coffee break				
SESSION: Detectors & sources in MIR II						
15:40	16:00	Filippos Kapsalidis	ETH Zurich	Switzerland	Contributed	Stable, High-Power Quantum Cascade Laser Frequency Combs operating in room temperature
16:00	16:20	Andreas Pfenning	University of Würzburg	Germany	Contributed	GaSb-based Resonant Tunneling Structures with Ternary Prewell Injectors for Room Temperature Mid-Infrared Applications
16:20	16:40	Kamil Pierściński	Institute of Electron Technology	Poland	Contributed	Analysis of heat dissipation schemes in QCLs
16:40	17:00	Vera Gramich	Fraunhofer Institute for Applied Solid State Physics	Germany	Contributed	Type-II Superlattice Photodetector Developments in the Mid-Infrared Region
17:00	17:20	Ruijun Wang	Ghent University - IMEC	Belgium	Contributed	Widely tunable 2.3 μm InP-based type-II DFB laser array heterogeneously integrated on silicon for sensing
17:20	17:40	Marcin Motyka	Wroclaw University of Science and Technology	Poland	Contributed	Carrier dynamics in GaSb-based quantum wells emitting in the 2 μm range
17:40	End of the day					
19:30	Conference Dinner in Downtown					



Tuesday - 16.05.2017						
SESSION: Laser sources I						
10:00	10:40	Maciej Bugajski	Institute of Electron Technology	Poland	Invited	Strain-compensated AlInAs/InGaAs/InP quantum cascade lasers
10:40	11:20	Rui Yang	Oklahoma University	USA	Invited	Recent progress in interband cascade devices
11:20	11:40	<i>Coffee break</i>				
SESSION: Laser sources II						
11:40	12:00	Krzysztof Abramski	Wroclaw University of Science and Technology	Poland	Contributed	Fully-fiberized Multi-wavelength Difference Frequency Generation Mid-infrared Source for Laser Spectroscopy Applications
12:00	12:20	Mehran Shahmohammadi	ETH Zurich	Switzerland	Contributed	Dual-wavelength DFB Quantum Cascade Lasers for NO and NO ₂ Sensing
12:20	12:40	Piotr Gutowski	Institute of Electron Technology	Poland	Contributed	MBE Growth and Fabrication of In _x Ga _{1-x} As/ Al _{0.45} Ga _{0.55} As/GaAs Strained Quantum Cascade Lasers
12:40	13:00	Peter Moselund	NKT Photonics	Denmark	Contributed	Mid-infrared supercontinuum - A maturing technology
13:00	13:20	Tomasz Czyszanowski	Lodz University of Technology	Poland	Contributed	Quantum-cascade vertical-cavity surface-emitting laser
13:20	13:40	Marta Gładysiewicz	Wroclaw University of Science and Technology	Poland	Contributed	Electronic band structure and material gain in GaSb-based quantum wells containing bismuth: Toward enhancement of quantum confinement in the valence band
13:40	14:30	<i>Lunch break</i>				
14:30	15:30	<i>Poster session with coffee</i>				
SESSION: Sensing systems III						
15:30	16:10	Barry McManus	Aerodyne Research Inc.	USA	Invited	Recent progress in trace gas instrument development at Aerodyne Research, Inc.
16:10	16:50	Ruifeng Kan	Chinese Academy of Sciences	China	Invited	MIR TDLAS technology for industrial emission and environmental monitoring
16:50	17:10	Robert Heinrich	Siemens AG	Germany	Contributed	High performance spectroscopy of hydrocarbon gas mixtures in the 6-11 μm range
17:10	17:30	Oleg Aseev	EMPA	Switzerland	Contributed	Breath alcohol - high precision measurement of VOCs using a DFB-QCL
17:30	17:50	Anna Ghetti	CRN, Institute for photonics and nanotechnologies	Italy	Contributed	TDLAS Determination of Carbon Dioxide Isotope Ratio for Diagnosis of Helicobacter Pylori
17:50		<i>End of the day</i>				
Wednesday - 17.05.2017						
SESSION: Sensing systems IV						
09:00	09:20	Peter Geiser	NEO Monitors AS	Norway	Contributed	In-situ H ₂ S and SO ₂ tail gas analysis with near- and mid-infrared TDLS
09:20	09:40	Grzegorz Dudzik	Wroclaw University of Science and Technology	Poland	Contributed	IQ demodulation-based gas sensing detection system for the Photothermal and Chirped Laser Dispersion Spectroscopy
09:40	10:00	Manuel Graf	EMPA	Switzerland	Contributed	Compact and Lightweight Multipass Cell Designs with Optimized Beam Propagation
10:00	10:20	Lorenzo Cocola	CRN, Institute for photonics and nanotechnologies	Italy	Contributed	Temperature Measurements From 2 μm Carbon Dioxide Absorption Spectrum
10:20	10:40	Yu-Pei Tseng	Technical University of Denmark	Denmark	Contributed	Upconversion Detection for Gas Sensing Applications
10:40	11:00	Teemu Kääriäinen	VTT Technical Research Centre of Finland Ltd.	Finland	Contributed	Stable isotope analysis of ¹³ CH ₄ and CH ₃ D in mixed biogenic and fossil methane samples
11:00	11:20	<i>Coffee break</i>				



SESSION: Laser sources III						
11:20	11:40	Yves Bidaux	ETH Zurich	Switzerland	Contributed	Waveguide engineering for low dispersion mid-infrared Quantum Cascade Lasers frequency combs
11:40	12:00	Grzegorz Haidás	Rzeszów University of Technology	Poland	Contributed	Tuning Quantum Cascade Laser Wavelength by the Injector Doping
12:00	12:20	Ieva Šimonytė	Brolis Semiconductors	Lithuania	Contributed	GaSb SLDs and gain-chips for sensing applications in the 2-2.5 micron wavelength range
12:20	12:40	Emilia Pruszyńska-Karbownik	Institute of Electron Technology	Poland	Contributed	Quantum cascade lasers with nonuniformly tapered waveguides
12:40	13:00	Mateusz Dyksik	Wrocław University of Science and Technology	Poland	Contributed	Triple quantum wells for active regions of mode-locked ICLs in the mid-infrared
13:00	13:20	Sven Höfling	University of Würzburg	Germany	Contributed	Interband Cascade Lasers on GaSb Substrates emitting beyond 5.6µm
13:20	14:00	Lunch break				
SESSION: Laser sources IV						
14:00	14:40	Jerry Meyer	Naval Research Laboratory	USA	Invited	Advances in Interband Cascade Lasers and LEDs
14:40	15:20	Johannes Koeth	Nanoplus	Germany	Invited	Specialized Lasers Sources for Sensing in the MIR
15:20	15:30	Closing Remarks				
15:30		End of the workshop				

Summary

According to the original dissemination plan, the iCspec consortium organized a workshop in the subject of laser based gas sensing: Mirsens 4 “International workshop on opportunities and challenges in mid-infrared laser-based gas sensing”. Based on a feedback from the participants it was a very successful event, both scientifically as well as from the point of view of personal contacts and informal information exchanges and consultations. It involved more than 80 researchers, engineers and company managers from various industrial laboratories and universities from all over the world. It was also an important dissemination channel for iCspec to inform about the Project work and achievements and reach as wide an audience as possible. More details can be found on the workshop website: <http://mirsensconference.org/>.