OFS29 Guide

29th International Conference
On Optical Fiber Sensors

2025 May 25–30
Porto, Portugal

OFS-29 ORGANIZATION

INESCTEC SPIE.

INSTITUTIONAL SUPPORT

PRR Plano de Recuperação e Resiliência

REPÚBLICA PORTUGUESA

Financiado pela União Europeia NextGenerationEU

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EPIC EUROPEAN PHOTONICS INDUSTRY CONSORTIUM

27th International Conference on Optical Fiber Sensors OFS 2022 August 29–September 2, 2022 | The Westin Alexandria | Alexandria, Virginia, USA

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OFS29 Guide

Welcome

The International Conference on Optical Fiber Sensors (OFS), established in 1983, is acknowledged as the world's leading conference on all topics related to photonic sensing principles and technologies supported in fiber optics, providing a forum for reporting and exchanging ideas on the latest advances in the field. It has also contributed significantly to industrialization and standardization of the related devices and systems for field deployment.

At the beginning of the 1980s, the recognition of the opportunity for high-performance sensing associated with optical fiber led to the development of a new R&D field, creating a community that had its first meeting in London in April 1983, which became identified as OFS1-1th International Conference on Optical Fiber Sensors.

Since then, 28 editions of this conference have taken place every 18 months (except in the pandemic time), moving across Europe/Middle East/Africa, Americas, and Asia/Pacific in accordance with the principle established long ago of "following the light" (the Sun). Over this period of more than 40 years the field expanded enormously in consequence of progress in multiple scientific and technological domains, also the diversity of applications where sensing supported by optical fiber presents comparative advantages.

Now is the time for the twenty-ninth edition of this conference, OFS29, which takes place in Porto, Portugal, from 25-30 May 2025. It is demanding the responsibility of organizing an event that does justice to the prestigious history of this emblematic conference. Being aware of that, we will do our best to build a scientific program of recognized quality, a showcase where companies all around the world demonstrate their technologies and optical sensing equipments, a context where different generations of researchers and entrepreneurs meet and feel encouraged to share their experiences and goals, a welcoming environment that helps everyone feel at home.

In short, we express our commitment to do our best to turn this a reality, looking for a meeting tuned to the culture and values that have guided OFS over the years.

José Luís Santos
Manuel Lopez-Amo Sainz
Tong Sun

OFS29 Program

Sunday May 25th

14:00 – 18:00 Instalation Technical Exhibition

14:00 – 18:00
Registration

Monday May 26th

08:00 –
Registration

10:00 – 13:00 Instalation Technical Exhibition

10:30 – 12:00 M1
Tutorial A1
Tutorial B1

12:00 – 13:00
Lunch
for tutorial attendees

13:00 – 14:30 M2
Tutorial A2
Tutorial B2

14:45 **Exhibition Opening** M3

15:00 – 16:30
Workshop A M4
3 invited talks

16:30 – 17:00 Coffee Break

17:00 – 18:00 M5
Workshop B
2 invited talks

18:30 – 20:00 M6
Welcome Reception

Tuesday May 27th

08:00 –
Registration

09:00 – 09:30 Tu1
Opening Cerimony

09:30 – 10:30 Tu2
Plenary Session I

10:30 – 11:00 Coffee Break

11:00 – 13:00 Tu3
Distributed Sensing I
1 invited talk
6 oral presentations

13:00 – 14:30 (90 minutes)
Lunch
TPC meeting

14:30 – 16:00 Tu4
New Elements, Effects, or Technologies and Materials for Photonic Sensing
1 invited talk
4 oral presentations

16:00 – 16:30 Coffee Break

16:30 – 17:30 Tu5
Distributed Sensing II
1 invited talk
2 oral presentations

17:30 – 19h Tu6
Poster Session I

Free Time

Opening and Closing Cerimonies / Social Events
Technical Exhibition / Exhibitiors Plenary Session
Tutorials / Workshops / Poster Sessions
Plenary Sessions / Invited Talks / Oral Presentations

Wednesday May 28th

08:00 –
Registration

08:30 – 09:30 W1
Plenary Session II

09:30 – 11:00 W2
Integrated Photonics, Cavity Optomechanics and Quantum Sensing
1 invited talk
4 oral presentations

11:00 – 11:30 Coffee Break
OFS29 Photo

11:30 – 13:00 W3
Micro-Nano Sensors
1 invited talk
4 oral presentations

13:00 – 14:00 (60 minutes)
Lunch
IHC meeting

14:00 – 15:30 W4
Smart Structures
1 invited talk
4 oral presentations

15:30 – 16:00 Coffee Break

16:00 – 17:30 W5
Poster Session II

17:30 – 19:15 W6
Exhibitors
Plenary Session

19:30 BUSES DEPARTURE

20:00 – 23:00 W7
Committees + Chairs Dinner

Thursday May 29th

08:00 –
Registration

08:30 – 09:30 Th1
Plenary Session III

09:30 – 9:45 ***In Memoriam*** Th2

09:45 – 11:15 Th3
Biochemical Sensing
1 invited talk
4 oral presentations

11:15 – 11:30 Coffee Break

11:30 – 13:00 Th4
Environment, Security, Defence, Industrial Applications, Technology Commercialization
1 invited talk
4 oral presentations

13:00 – 14:30 (90 minutes)
Lunch
ISC meeting

14:30 – 16:00 Th5
Interferometric/ Distributed Sensors
1 invited talk
4 oral presentations

16:00 – 16:30 Coffee Break

16:30 – 18:00 Th6
Poster Session III

18:00 BUSES DEPARTURE

20:00 – 24:00 Th7
Conference Banquet

Friday May 30th

09:30 – 11:00 F1
Physical, Mechanical and Eletromagnetic Sensors
1 invited talk
4 oral presentations

11:00 – 11:30 Coffee Break

11:30 – 12:45 F2
Post Deadline Session

12:45 – 13:15 F3
Closing Cerimony

13:15 – 14:30
Lunch

16:30 – 18:00
Douro River Trip

Organization and Institutional Support

ORGANIZATION

INESC TEC Institute for Systems and Computer Engineering, Technology and Science

INSTITUTIONAL SUPPORT

- Visit Portugal
- Visit Porto & North of Portugal
- PRR Plano de Recuperação e Resiliência
- República Portuguesa
- European Union: NextGenerationEU
- European Photonics Industry Consortium (EPIC)
- 27th International Conference on Optical Fiber Sensors (OFS2022)
- 28th International Conference on Optical Fiber Sensors (OFS28)

OFS Format

The OFS conferences has an established format along the following guidelines:

Option for no parallel sessions, with the program developing sequentially between periods in the auditorium (plenary and invited talks and oral presentations), and also periods in spaces where the exhibition and discussion of contributions in posters take place;

Thematic sessions spread over three and a half days along the conference week (from Tuesday until Friday morning);

Technical exhibition where companies and institutions exhibit their products and activity in fiber optic sensing and related fields;

On Monday of the conference week are held tutorials and workshops on relevant topics in fiber optic sensing and related fields;

The social program has two fixed events: the welcome reception on Monday evening and the gala dinner on Thursday; others may be considered depending on the organisation of a particular edition of the conference;

During the conference, plenary meetings of the three OFS committees will take place: Steering Committee, Technical Program Committee, International Honorary Committee.

OFS29 Features

The Conference program will include

Invited oral contributions given by recognized authorities in the broad domain of optical sensing and related R&D fields;

Submitted contributions all undergoing a peer review process on the basis of a full-length manuscript, following acceptance criteria based on quality, relevance and originality;

Evaluation and prospective assessment of the exploitation and commercialization of optics/fiber optics sensing technology;

Workshops on selected topics mostly orientated to post-graduation students;

Workshops on edge topics in the field;

Technical Exhibition.

Optical fiber sensors and related concepts and technologies will represent the core of the conference. Contributions would cover novel sensing principles, advanced transducers based on artificial materials, new subsystems combined with advanced signal processing, multi-point and distributed sensing, as well as new applications and the exploitation of this sensing technology.

Conference Proceedings
Accepted contributions will be compiled into the Conference Proceedings edited by SPIE.

Online Access to Technical Digest
Registered OFS29 participants have full access to the conference proceedings from SPIE Digital Library accessible from https://SPIEDigitalLibrary.org/ and inserting the credentials provided by the OFS29 organization.

Special Issue
In addition to the Conference Proceedings, the authors are invited to submit an extended version of the accepted papers for an OFS29 dedicated Special Issue of Journal of Lightwave Technology.

OFS29 Scope and Topics

Optical Fiber Sensors will be the core of the Conference, but the scope is wide enough to include new concepts, developments, and applications in the field of optical fiber science and technology and related areas.
Relevant topics include, but are not limited to:

PHYSICAL AND MECHANICAL SENSORS // Temperature // Pressure // Strain // Vibration // Acceleration // Flow // Rotation // Displacement // Others

ELECTROMAGNETIC SENSORS // Magnetic Field // Electric Field // Current // Voltage

CHEMICAL AND ENVIRONMENTAL // Chemical Sensors // Remote Spectroscopy // Environmental Monitoring // Security // Defense and Industrial Applications

BIOLOGICAL AND MEDICAL SENSORS // Sensing for Biophotonics // OCT Imaging // Instrumentation for Life Sciences // In-Vivo Applications

INTERFEROMETRIC & POLARIMETRIC SENSORS // Gyroscopes // Hydrophones // Geophones // Acoustic Sensor Arrays

DISTRIBUTED SENSING // Time // Frequency and Coherence Domain Reflectometry // Rayleigh, Raman and Brillouin Detection Techniques // Sensing Cable Designs // Standard and Novel Applications

MULTIPLEXING AND SENSOR NETWORKING // Topologies and Theories // Multiplexing Techniques //Applications

PASSIVE & ACTIVE DEVICES FOR PHOTONIC SENSING // Sources // Detectors // Modulators // Specialty Fibres // Integrated Optics Devices // Fibre Gratings // MEMS // Micro-Optic Components

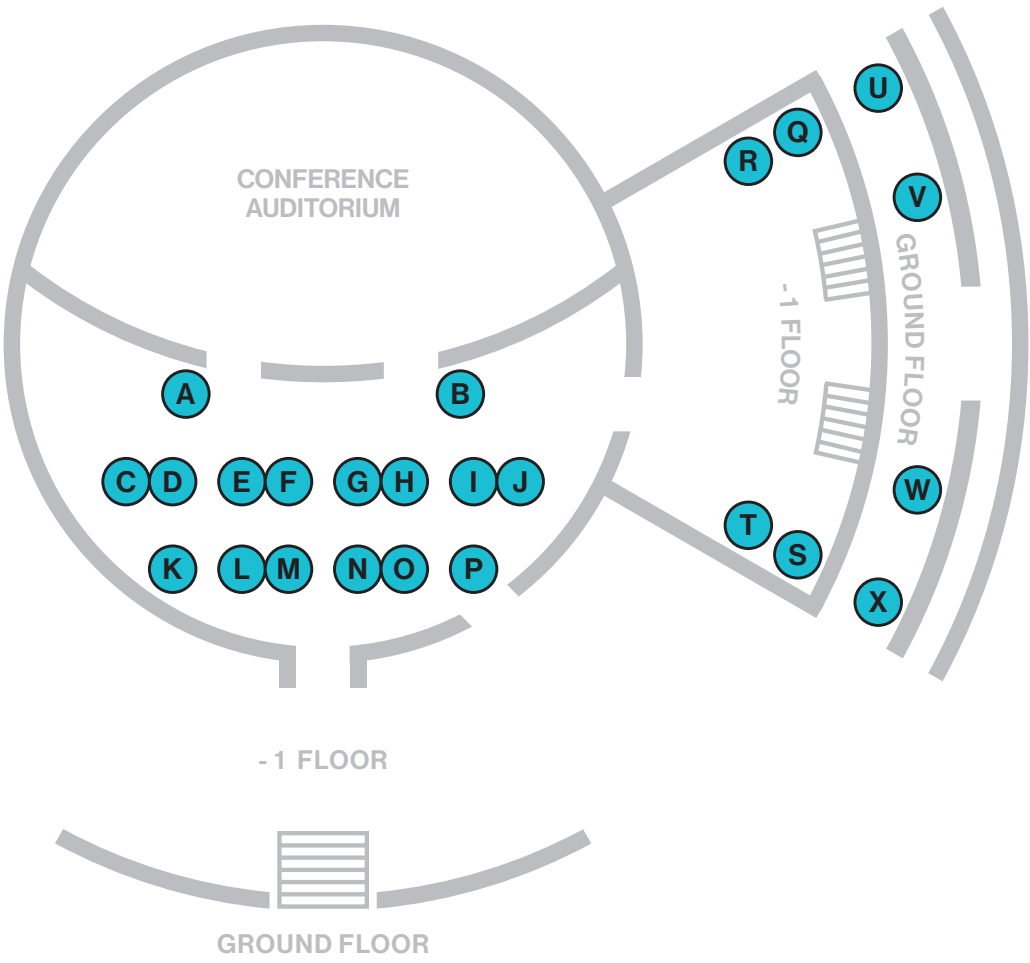
NEW CONCEPTS FOR PHOTONIC SENSING // Optical Quantum Sensing Principles and Technology Challenges // Photonic Crystal Fibres // Hollow Core Fibres // Nanomaterials and Nano-Optical Devices // Metamaterials // Diffractive Optics // Plasmonic Based Sensing

SIGNAL PROCESSING FOR FIBER OPTIC SENSING // Genetic Algorithms // Neural Networks // Data Fusion // Pattern Recognition // Statistical Methods // Virtual Instrumentation

SMART STRUCTURES AND SMART MATERIALS // Structural Health Monitoring // Strain and Deformation Sensors // Fibre Embedding Techniques // Condition Monitoring Algorithms

SYSTEM APPLICATIONS AND FIELD TRIALS // Relevant Installations and Field Demonstration of Photonic-based Sensing Systems // Metrology Projects // Standardization // Commercialization

OFS29 Exhibition



The Conference will include an Exhibition event where companies/institutions with activity in optical fiber sensing and optical fiber technology in general have the opportunity to show their latest products/initiatives.

As shown in the following figure, Exhibition will happen in the foyer spaces of the Congress Center where the Conference will be held, enabling very close interaction with OFS29 delegates and guests.

The Exhibition space is split in three regions. In the first one are located the booths A-P with cost €3500+VAT (except the booths D-I, which are reserved to Gold/Silver Exhibitors), the second one includes the booths Q-T with cost €3000+VAT, and the third one aggregate the booths U-X with cost €2750+VAT.

Besides the access to all infrastructures required for a booth operation, Regular Exibitors are provided by lunch and coffee vouchers for one person for 27, 28, 29, 30, May, as well as access to a standard time slot (3 minutes) in the Exhibitor's Plenary Session.

Gold/Silver Exhibitors has right to additional benefits, as summarized in the following table.

Exhibitor's Plenary Session
Wednesday May 28th – 17:45

Order of presentation:
Gold Exhibitors
Silver Exhibiters
Regular Exhibitors.

In each category the order will follow the registration timeline.

Gold Exhibitor

- Two individual full Conference registrations
- One Exhibition Booth at privileged location
- Display of Sponsor Logo on the Conference Screen
- Large Sponsor Logo on Conference proceedings
- Large Sponsor Logo on Conference website
- Gold time slot (7 minutes) in the Exhibitor's Plenary Session
- Inclusion of Sponsor promotional literature in the participant's courtesy bags
- Inclusion of Gold Sponsor Logo of the Conference in the Sponsor website

Silver Exhibitor

- One individual full Conference registration
- One Exhibition booth at privileged location
- Sponsor Logo on Conference proceedings
- Sponsor Logo on Conference website
- Silver time slot (5 minutes) in in the Exhibitor's Plenary Session

OFS29 Exhibitors

by order of registration

BOOTH A
FiberPro

BOOTH C
Redondo Optics

BOOTH R
Ibsen

BOOTH V
Optoeletro-Tek

BOOTH T
Wires&Bytes

BOOTH N
Flyin Group

BOOTH P
FBGS

BOOTH B
Photonics Bretagne

BOOTH K
Technica Optical Components

BOOTH O
Xiamen Beogold Technology

BOOTH S
Indie (Exalos/Teraxion)

BOOTH Q
Notice

BOOTH U
Aragon Photonics

BOOTH L
University of Electronic Science and Technology of China

Photonics Sensors

Gold Exhibitors

BOOTH F
HBK Fibersensing

BOOTH H
Exail

BOOTH J
Luna

BOOTH X
Yangtze Optical Eletronic

Silver Exhibitors

BOOTH D
Shandong Micro Sensor Photonics

BOOTH E
Thorlabs GmbH

BOOTH G
Northlab Photonics

BOOTH I
B-Sens

BOOTH M
Febus-Optics

BOOTH W
FiberLogix

OFS 29 Awards

Paper Awards	**Best Paper Award** For the paper with the best mark in the combination evaluation score and presentation performance
	Best Student Paper Awards Following the same criteria, the best student paper in each of the four following categories: • Physical and Mechanical Sensors • Chemical, Environmental, Biomechanical, and Medical Sensors • Electromagnetic, Interferometric, Polarimetric, New Concepts • Distributed, Multiplexing, System Applications, and Field Trials
Lifetime Awards	To honor two researchers who have significantly contributed to the development of this area of Human knowledge.

In Memoriam

Moment of introspection and recognition of Members of our Community who are no longer with us, with a life of contributions to the development of the fiber optic sensing field.

Thursday May 29th – 9:30

Meetings of OFS Committees

During the conference, meetings of the three OFS committees will take place according to the following calendar.

Technical Program Committee
Tuesday May 27th – 13:00–14:30

International Honorary Committee
Wednesday May 28th – 13:00–14:00

International Steering Committee
Thursday May 29th – 13:00–14:30

OFS29 Group Photo

The group photo of participants at OFS29 will be recorded

Thursday May 29th – 11:15

OFS29 Social Program

In addition to the lunches and coffee breaks that will take place in spaces adjacent to the auditorium, poster hall and exhibition, OFS29 will include the following social events.

The Welcome Reception will happens in the spaces where the conference will take place. For other events, transportation will be provided by bus.

Welcome Reception
Monday May 26th – 18:30–20:00

Committees + Chairs Dinner
Wednesday May 28th – 20:00–23:00

Conference Dinner
Thursday May 29th 20:00–24:00

Douro River Trip
Friday May 30th – 16:30–18:00

OFS29 Committees

General Chair

José Luís Santos. Universidade do Porto (Portugal)

Technical Program Chairs

Prof Manuel Lopez-Amo Sainz. Universidad Pública de Navarra (Spain)
Prof Tong Sun. City St George's, University of London (United Kingdom)

International Steering Committee

Prof Avinoam Zadok. Bar Ilan University (Israel)
Dr Geoff Cranch. Naval Research Laboratory (United States of America)
Prof Gilberto Brambilla. University of Southampton (United Kingdom)
Prof Hypolito Jose Kalinowski. Universidade Federal Fluminense (Brazil)
Prof John Canning. University of Southern China (China)
Prof José Luís Fabris. Universidade Federal de Tecnologia (Brazil)
Prof José Luís Santos. Universidade do Porto (Portugal)
Prof Julian Jones (OFS General Secretary). Heriot-Watt University (United Kingdom)
Prof Kara Peters. North Carolina State University (United States of America)
Prof Kentaro Nakamura. Tokyo Institute of Technology (Japan)
Prof Kwang Yong Song. Chung-Ang University (Republic of Korea)
Prof Miguel Gonzalez Herraez. University of Alcala (Spain)
Prof Wei Jin. Hong Kong Polytechnic University (China)

Technical Program Committee

Dr Ali Masoudi. University of Southampton (United Kingdom)
Prof Alselmo Frizera Neto. Universidade Federal do Espírito Santo (Brazil)
Prof Andrea Cusano. Universita di Sanio (Italy)
Prof Avishay Eyal. Tel Aviv University (Israel)
Prof Bai-Ou Guan. Jinan University (China)
Prof Balaji Srinivasan. Indian Institute of Technology Madras (India)
Dr Clay Kirkendall. Naval Research Laboratory (United States of America)
Prof Christos Markos. Technical University of Denmark (Denmark)
Prof Denis Donlagic. University of Maribor (Slovenia)
Prof Eric Fujiwara. Universidade Estadual de Campinas (Brazil)
Dr Gabriele Bolognini. Bologna UNIT-CNR (Italy)
Prof Hideaki Murayama. University of Tokyo (Japan)
Prof Fumihiko Ito. Shimane University (Japan)

Prof Jean Carlos Cardozo da Silva. Universidade Federal Tecnológica do Paraná (Brazil)
Dr João Batista Rosolem. CPqD-Telecommunication R&D Center (Brazil)
Dr Jonathan Wheeler. Northup Grumman (United States of America)
Prof Jun Yang. Guangdong University of Technology (China)
Dr Kwanil Lee. Korea Institute of Science and Technology (Republic of Korea)
Prof Libo Yuan. Guilin University of Eletronic Technology (China)
Prof Luca Palmieri. Universita di Padova (Italy)
Prof Luis Rodriguez Cobo. Universidad de Cantabria (Spain)
Prof Marcelo Soto. Universidad Técnica Federico Santa María (Chile)
Prof Marc Wuilpart. Université de Mons (Belgium)
Prof Margarita Varón Durán. Universidad Nacional de Colombia (Colombia)
Dr Martin Becker. Safran Eletronics&Defense (Germany)
Prof Michel Digonnet. Stanford University (United States of America)
Prof Ming Han. Michigan State University (United States of America)
Prof Min Yong Jeon. Chungnam National University (Republic of Korea)
Prof Nageswara Lalam. National Energy Technology Laboratory (United States of America)
Prof Pedro Jorge. Universidade do Porto (Portugal)
Prof Peter Dragic. University of Illinois (United States of America)
Prof Rainer Engelbrecht. Nuremberg Institute of Technology (Germany)
Dr Robert Lieberman. Lumoptix (United States of America)
Prof Satoshi Tanaka. National Defense Academy (Japan)
Dr Scott Brian Foster. Defence Science&Tech Organization (Australia)
Prof Stephen Warren-Smith. University of South Australia (Australia)
Prof Sylvain Girard. University of St Etienne (France)
Prof Tinko Eftimov. Université Du Québec (Canada)
Prof Waclaw Urbanczyk. Politechnika Wroclawska (Poland)
Dr Walter Margulis. Fiber Activity (Brazil)
Prof Yizheng Zhu. Virginia Polytechnic Institute and State University (United States)
Prof Yosuke Mizuno. Yokohama National University (Japan)
Prof Yosuke Tanaka. Tokyo University of Agriculture and Technology (Japan)
Prof Yuliya Semenova. Technological University of Dublin (Ireland)
Prof Yunjiang Rao. University of Electronic Science&Technology of China (China)
Prof Zhengying Li. Wuhan University of Technology (China)
Prof Zuyuan He. Shanghai Jiao Tong University (China)

International Honorary Committee

Dr Alan Kersey (United States)
Dr Alexis Mendez (United States)
Dra Anna Grazia Mignani (Italy)
Dr Anthony Dandridge (United States of America)
Prof Brian Culshaw (United Kingdom)
Prof Byoung Yoon Kim (Republic of Korea)
Prof David Jackson (United Kingdom)
Prof David Sampson (Australia)
Prof Eric Udd (United States of America)
Dr Glen Sanders (United States of America)
Dr Gordon Day (United States of America)
Dr Herve Lefevre (France)
Prof John Dakin (United Kingdom)
Prof Jose Miguel Lopez Higuera (Spain)
Prof Kazuo Hotate (Japan)
Prof Leszek Jaroszewicz (Poland)
Prof Luc Thévenaz (Switzerland)
Dr Marc Voet (Belgium)
Prof Moshe Tur (Israel)
Prof Nobuaki Takahashi (Japan)
Dr Pierre Ferdinand (France)
Prof Ralf Kersten (Germany)
Prof Reinhardt Willsch (Germany)
Prof Richard Claus (United States of America)
Prof Ryozo Yamauchi (Japan)
Dr Thomas Giallorenzi (United States of America)
Prof Wojtek Bock (Canada)
Prof Wolfgang Ecke (Germany)
Prof Yanbiao Liao (China)
Prof Youngjoo Chung (Republic of Korea)

Local Organizing Committee

Prof António Lobo Ribeiro. Universidade Fernando Pessoa (Portugal)
Prof Ariel da Silva Guerreiro. Universidade do Porto /INESC TEC (Portugal)
Prof Carla Carmelo Rosa. Universidade do Porto /INESC TEC (Portugal)
P**rof Carlos Alberto Marques**. Universidade do Aveiro (Portugal)
Carlos Gaspar. INESC TEC (Portugal)
Dra Catarina Monteiro. INESC TEC (Portugal)
Dr Claudio Floridia. INESC TEC (Portugal)
Dra Cristina Barbosa. HBK/Fibersensing (Portugal)
Dra Diana Filipa Guimarães. INESC TEC (Portugal)
Dr Francisco Moita Araújo. HBK/Fibersensing (Portugal)
Prof Gaspar Mendes Rego. Instituto Politécnico de Viana do Castelo/INESC TEC (Portugal)
Dr Ireneu Dias. INESC TEC (Portugal)
Dr João Castro Ferreira. INESC TEC (Portugal)
Dr José Carlos Sousa. INESC TEC (Portugal)
Prof José Manuel Almeida. Universidade de Trás-os-Montes e Alto Douro /INESC TEC (Portugal)
Prof José Manuel Batista. Universidade da Madeira/INESC TEC (Portugal)
Dra Lídia Vilas Boas. INESC TEC (Portugal)
Dr Luís Alberto Ferreira. HBK/Fibersensing (Portugal)
Dr Luís Costa Coelho. INESC TEC (Portugal)
Luísa Pereira Mendonça. INESC TEC (Portugal)
Prof Manuel Joaquim Bastos Marques. Universidade do Porto/INESC TEC (Portugal)
Prof Marta Ferreira. Universidade de Aveiro (Portugal)
Dr Nuno Azevedo Silva. INESC TEC (Portugal)
Dr Orlando Reis Frazão. INESC TEC (Portugal)
Prof Paulo Amorim Caldas. Instituto Politécnico de Viana do Castelo/INESC TEC (Portugal)
Prof Paulo Fernandes Antunes. Universidade de Aveiro (Portugal)
Prof Paulo Silva Marques. Universidade do Porto/INESC TEC (Portugal)
Prof Paulo Sérgio André. Universidade de Lisboa (Portugal)
Prof Pedro Alberto da Silva Jorge. Universidade do Porto/INESC TEC (Portugal)
Prof Susana Fernando. Escola Superior de Artes e Design (Portugal)
Dra Susana Novais. INESC TEC (Portugal)
Dra Susana Oliveira Silva. INESC TEC (Portugal)
University of Porto SPIE Chapter (Portugal)

OFS29 Invited Speakers

Plenary Speakers

Prof Christian Degen, Department of Physics, ETH Zurich (Switzerland)
Quantum Sensors in Diamond: Technology and Applications
Tuesday May 27th – 9:30

Prof Roberto Osellame, CNR - Institute for Photonics and Nanotechnologies (Italy)
Optical Sensing and Imaging in Femtosecond-Laser-Written Optofluidic Lab-On-Chip
Thursday May 29th –8:30

Dr Stuart Russell, Sintela Ltd (United Kingdom)
Distributed Acoustic Sensing (DAS) a Real-World Perspective, Requirements, Applications and Techniques
Wednesday May 28th –8:30

Session Invited Speakers

Prof. Andrea Cusano. Universidad di Sannio (Italy)
Lab on Fiber Technology: Towards Theranostics Endoscopes
Thursday May 29th – 9:45

Dr. Austin Taranta. University of Southampton (United Kingdom)
Recent Advances in Antiresonant Hollow Core Fibers for the Next Generation of Gyroscopes and Precision Fiber Sensors
Friday May 30th – 9:30

Prof. Brant Gibson. RMIT University (Australia)
Diamond-Doped Optical Fibres for Magnetometry Applications
Wednesday May 28th – 11:30

Prof. Chang-Seok Kim. Pusan National University (Korea)
Autonomous Vehicle 4D LiDAR Sensor based on OFDR Technology
Thursday May 29th – 11:30

Dr. Giuseppe Marra. National Physical Laboratory (United Kingdom)
Science with Seafloor Cables
Thursday May 29th – 14:30

Prof. Lan Yang. Washington University (United States of America)
Whispering-Gallery Microresonators Sensors: Fundamentals and Applications
Tuesday May 27th – 14:30

Prof. Miguel González Herráez. Universidad de Alcalá (Spain)
Distributed Acoustic Sensing in Submarine Optical Fibers
Tuesday May 27th – 11:00

Dr. Mikael Mazur. Nokia Bell Labs (United States of America)
Fiber Sensing using Live Fibers in the Deployed Fiber Grid
Wednesday May 28th – 14:00

Dr. Miguel Soriano. RISE (Sweden)
Time-Expansion Concept in Distributed Sensing
Tuesday May 27th – 16:30

Prof. Stefanie Kroker. Technische Universität Braunschweig (Germany)
Bringing Atoms and Ions onto a Chip:
Integrated Photonics for Compact and Robust Quantum Technologies
Wednesday May 28th – 9:30

Workshop Invited Speakers

Prof. Cristiano Cordeiro. Universidade Estadual de Campinas (Brazil)
Innovative Platforms for Optical Sensing: Hollow-Core and Biodegradable Optical Fibers
Monday May 26th – 17:30

Dr. Linh Nguyen. University of South Australia (Australia)
Sensing with multimode optical fibers: A machine learning perspective
Monday May 26th – 17:00

Prof. Yuan Gong. University of Electronic Science and Technology of China (China)
Fiber-optic Microlaser Biosensors
Monday May 26th – 16:00

Prof. Markus Schmidt. Leibniz Institute of Photonic Technology (Germany)
Optofluidic Microstructured Fibers: Exploring Nanoparticle Dynamics via Tracking Analysis
Monday May 26th – 15:30

Prof. Vasilis Ntziachristos. Technical University Munich (Germany)
Listening to Light: Optoacoustics and Fiber Sensors
Monday May 26th – 15:00

Tutorial Lecturers

Dr. Ali Masoudi. University of Southampton (United Kingdom)
Nonlinear Effects in Optical Fibers for Distributed Sensing
Monday May 26th – 10:30

Dr. Francesco Chiavaioli. CNR – Istituto di Fisica Applicata "Nello Carrara" (Italy)
Towards a Uniform Metrological Assessment of the Performance of Optical Fiber Sensors in Real-Life Contexts
Monday May 26th – 13:00

Dra. Anna Grazia Mignani / Dr. Leonardo Ciaccheri.
CNR – Istituto di Fisica Applicata "Nello Carrara" (Italy)
Pocket-Sized OpticalSspectroscopy: Revolutionizing Food Analytics at your Fingertips
Monday May 26th – 10:30

Dr. Hugo Martins. Consejo Superior de Investigaciones Científicas-CSIC (Spain)
Signal Processing in Distributed Fiber Optic Sensing
Monday May 26th – 13:00

OFS29 Session Chairs

Workshops

Workshop A Monday May 26th 15:00–16:30	*Biosensing* **Dr. Robert Lieberman**. Lumoptix, LLC (United States) **Prof. Pedro Jorge**. Universidade do Porto (Portugal)
Workshop B Monday May 26th 17:00–18:00	*Technologies in Fiber Optic Sensing* **Prof Satoshi Tanaka**. National Defense Academy (Japan) **Dr. Luis Rodrigue-Cobo**. Universidade de Cantabria (Spain)

Plenary Sessions

Plenary Session I Tuesday May 27th 9:30–10:30	**Prof Manuel Lopez-Amo Sainz** Universidad Pública de Navarra (Spain)
Plenary Session II Wednesday May 28th 8:30–9:30	**Prof Tong Sun** City St George's, University of London (United Kingdom)
Plenary Session III Thursday May 29th 8:30–9:30	**Prof Julian Jones** Heriot-Watt University (United Kingdom)

Regular Sessions

Tuesday May 27th 11:00–13:00	*Distributed Sensing I* **Dr. Kwanil Lee**. Korea Institute of Science and Technology (Republic of Korea) **Prof Luca Palmieri**. Universidad degli Studi di Padova (Italy)
Tuesday May 27th 14:30–16:00	*New Elements, Effects, or Technologies and Materials for Photonic Sensing* **Prof Sylvain Girard**. University Jean Monnet Saint-Etienne (France) **Dr Ali Masoudi**. University of Southampton (United Kingdom)
Tuesday May 27th 16:30–17:30	*Distributed Sensing II* **Prof Yun-Jiang Rao**. University of Electronic Science and Technology of China (China) **Prof Avishay Eyal**. Tel Aviv University (Israel)
Wednesday May 28th 9:30–11:00	*Integrated Photonics, Cavity Optomechanics and Quantum Sensing* **Prof Fumihiko Ito**. Shimane University (Japan) **Dr Rainer Engelbrecht**. Technische Hochschule Nurenberg (Germany)
Wednesday May 28th 11:30–13:00	*Micro-Nano Sensors* **Prof Moshe Tur**. Tel Aviv University (Israel) **Prof Yosuke Mizuno**. Yokohama National University (Japan)
Wednesday May 28th 14:00–15:30	*Smart Structures* **Prof Jean Carlos Cardozo Da Silva**. Universidade Tecnológica Federal do Paraná (Brazil) **Prof Hideaki Murayama**. The University of Tokyo (Japan)
Thursday May 29th 9:45–11:15	*Biochemical Sensing* **Prof Eric Fujiwara**. State University of Campinas (Brazil) **Dr Stephen Warren-Smith**. University of South Australia (Australia)

Thursday May 29th 11:30–13:00	***Environment, Security, Defence, Industrial Applications, Technology Commercialization*** **Prof Anselmo Frizera-Neto**. Universidade Federal do Espírito Santo (Brazil) **Prof Andrea Cusano**. University Di Sanio (Italy)
Thursday May 29th 14:30–16:00	***Interferometric/Distributed Sensors*** **Prof Marc Wulpart**. University de Mons (Belgium) **Prof Yosuke Tanaka**. Tokyo University of Agriculture and Technology (Japan)
Friday May 30th 9:30–11:00	***Physical, Mechanical and Eletromagnetic Sensors*** **Dr Gabriele Bolognini**. Istituto per la Microelettronica e Microsistemi (Italy) **Prof Luc Thévenaz**. EPFL (Switzerland)

Post-Deadline Session

Friday May 30th 11:30–12:45	**Prof Jose Miguel Lopez Higuera**. Universidad de Cantabria (Spain) **Prof Zuyuan He**. Shanghai Jiao Tong University (China)

OFS29 Registration

The values of the registration fee (regular, access to tutorials/workshops, accompanying person) are shown in the following table.

Registration	up to 2025 March 31st	from 2025 April 1st
Normal	€ 650	€ 750
Student	€ 500	€ 600
Normal SPIE Member	€ 625	€ 725
Student SPIE Member	€ 475	€ 575
Accompanying Person	€ 300	€ 300

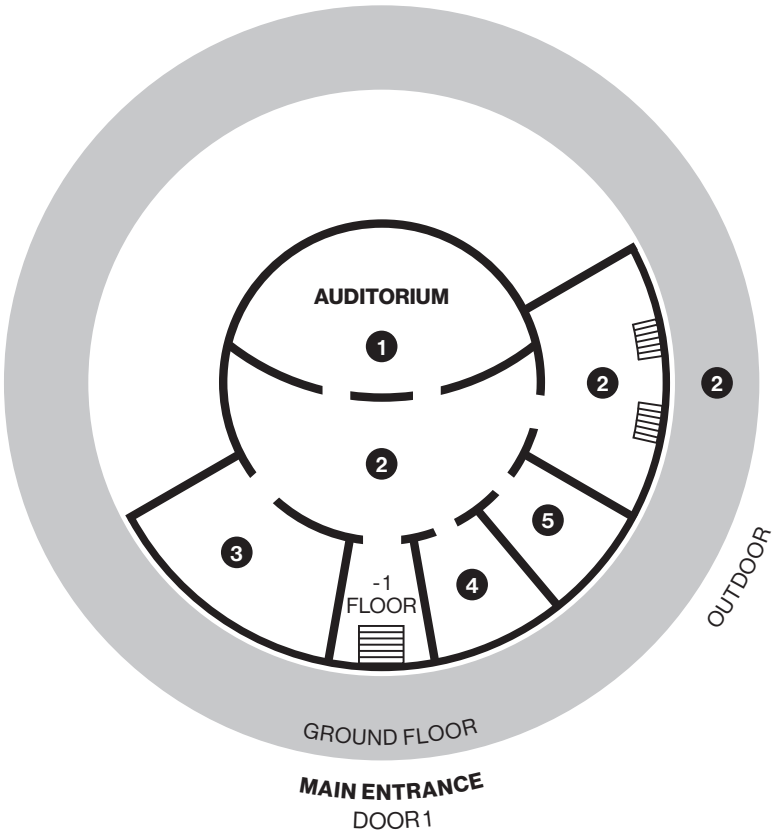
Registration Tutorials	up to 2025 March 31st	from 2025 April 1st
Normal	€ 125	€ 150
Student	€ 75	€ 100

The regular registration fee includes	Workshops on the afternoon of 26th May Full access to all conference sessions Conference proceedings Lunches on 27th, 28th, 29th and 30th May 2025 Coffee-breaks on 26th, 27th, 28th, 29th and 30th May 2025 Welcome Cocktail on 26th May 2025 Gala Dinner on 29th May 2025 Douro River Cruise on 30th May 2025
The accompanying person program includes	Welcome Cocktail on 26th May 2025 Trip Douro Region on 27th May 2025 Trip Porto City on 28th May 2025 Gala Dinner on 29th May 2025 Douro River Cruise on 30th May 2025

OFS29 Venue

Jardins do Palácio de Cristal
Super Bock Arena
Rua de Dom Manuel II
4050-346 Porto. Portugal

The conference will be held in one of the most iconic locations in Porto, the so-called *Jardins do Palácio de Cristal*, where one of the City's Congress Center is located. This space, located close to the city center, has the typical structure of the European gardens of the 18th and 19th centuries, providing visitors with impressive perspectives of the old city, the Douro River and its mouth in the Atlantic Ocean.



1. Plenary Sessions
   Presentations
   Cerimonies
2. Technical
   Exhibition
3. Poster Sessions
   Tutorial A
4. Work Area
5. Meeting Room

LUNCH AREA

OFS29
Technical Program
May 26th — 30th
2025

Monday May 26th 2025

M1 Tutorial A *Core Topics for Distributed Fiber Optic Sensing*

M1 – T1 **Dr. Ali Masoudi**
10:30–12:00 University of Southampton (United Kingdom)

Nonlinear Effects in Optical Fibers for Distributed Sensing

In this Tutorial, we will explore the critical role of nonlinear effects in optical fibers for distributed sensing applications. We will start with a brief introduction to distributed sensing and the scattering mechanisms in optical fibers. Following this, we will delve into key nonlinear effects, including Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS), and modulation instability. We will examine the adverse impacts of these nonlinearities on linear Distributed Optical Fiber Sensors (DOFS) such as Raman and Rayleigh-based distributed sensors.

The Tutorial will then focus on Brillouin Optical Time-Domain Analysis (BOTDA) systems, which harness SBS to achieve a Brillouin gain spectrum with a high signal-to-noise ratio (SNR). We will discuss the sensing principles of BOTDA systems and compare different system architectures. Additionally, a brief overview of Brillouin Optical Correlation-Domain Analysis (BOCDA) systems and their operating principles will be provided. We will conclude with insights on the advantages of leveraging nonlinear effects in advanced sensing technologies.

M1 – T2 **Dr. Hugo Martins**
13:00–14:30 Consejo Superior de Investigaciones Científicas–CSIC (Spain)

Signal Processing in Distributed Fiber Optic Sensing

The whole is greater than the sum of its parts. Distributed Fiber Optic Sensing (DFOS) allow for a single interrogator to measure a large number of points, but specific and key advantages can be further gained from processing DFOS as a coherent network array of sensors. Effective image denoising algorithms have been demonstrated in BOTDA, since instrumental noise will affect all channels similarly. Pulse coding techniques allow for gains of SNR that surpass those of simple averaging. In DAS, using the coherency of signals arriving to multiple channels, the fiber position in the field (and physical location of noise sources relative to it) can be mapped, and measurements with sensitivity below ambient noise can be performed. With the addition of a full new dimension (space), a multitude of waves can be mapped in seismology, even when overlapping in the same frequency band. We will review signal processing considerations specific to DOFS.

M2 Tutorial B *Core Topics in Fiber Optic Sensing*

M2 – T1
10:30–12:00

Dra. Anna Grazia Mignani and **Dr. Leonardo Ciaccheri**
National Research Council of Italy (CNR)
Institute of Applied Physics "Nello Carrara" – IFAC (Italy)

Pocket-Sized Optical Spectroscopy: Revolutionizing Food Analytics at your Fingertips

Optical spectroscopy is transforming food analysis by providing a cost-effective and eco-friendly alternative to traditional methods. With its ability to deliver rapid and non-destructive measurements without the need for harmful chemicals or solvents, it allows green analytics for food quality and safety assessment. By integrating chemometrics or AI-powered algorithms, optical spectroscopy can decode complex data and perform simultaneous analysis of multiple food components. A single flash of light, combined with advanced spectroscopic training, enables comprehensive quantitative and qualitative assessments of various nutraceutical indicators in one go. It's an intelligent and sustainable solution for achieving superior food quality and safety standards.

Photonic technologies initially developed for telecommunications, generated an explosion of compact light sources, detectors, micro-spectrometers, spectral sensors, fiber optics, and micro-photonic components. These innovations are now transforming food control, providing compact, robust, and low-cost instruments that are perfect for online applications by users with minimal technical training, as well as by consumers.

In this tutorial, we will show the the latest and most compact optical spectroscopy devices, with a special attention to those operating in the near-infrared, and to pocket-sized and smartphone-connected models. We will show their applications in food analysis and showcase their potential through a live demo. Get ready to see how these powerful tools can revolutionize food multi-component analyses, and discover opportunities for future collaborations.

M2 – T2
13:00–14:30

Dr. Francesco Chiavaioli
National Research Council of Italy (CNR)
Institute of Applied Physics "Nello Carrara" – IFAC (Italy)

Towards a Uniform Metrological Assessment of the Performance of Optical Fiber Sensors in Real-Life Contexts

Optical fiber sensors (OFSs) are dramatically spreading worldwide not only in the scientific research, but also in the industrial market. Given their peculiarities, OFSs are applied to countless different applications, such as physics, engineering, material science, biochemistry and medicine. However, it is still very cumbersome to uniformly compare their performance. Therefore, there is an urgently need for defining the fundamentals of metrological parameters to uniformly assess the performance of optical fiber sensors, and hence to make the their comparison easier. The tutorial will encompass commonly-used performance parameters (sensitivity, resolution, limit of detection, selectivity) and some other parameters of generic interest (accuracy, stability, repeatability and reproducibility). Common mistakes still present in the literature will also be highlighted. The concepts discussed can be applied to any resonance-based sensor, thus providing the basis for an easier and direct performance comparison of a great number of sensors published in the literature up to now.

M3 14:45–15:00 **Exhibition Opening**

M4 Workshop A ***Biosensing***

CHAIRS

Dr. Robert Lieberman
Lumoptix, LLC (United States)

Prof. Pedro Jorge
Universidade do Porto (Portugal)

M4 – W1
15:00–15:30

Prof. Vasilis Ntziachristos
Technical University Munich (Germany)

Listening to Light: Optoacoustics and Fiber Sensors

Biological discovery is a driving force of biomedical progress. With rapidly advancing technology to collect and analyse information from cells and tissues, we generate biomedical knowledge at rates never before attainable to science. Nevertheless, conversion of this knowledge to patient benefits remains a slow process. To accelerate the process of reaching solutions for healthcare, it would be important to strongly complement this culture of discovery with a culture of problem-solving in healthcare. The talk focuses on recent progress with optical and optoacoustic technologies, in particular fiber sensors and their application to widely employed optoacoustic modalities, including Multispectral Optoacoustic Tomography (MSOT) and Raster-scan Optoacoustic Mesoscopy (RSOM).

The talk reviews advances in fiber sensors for the detection of ultrasound / optoacoustic signals and their implementation into optoacoustic approaches, which, when aided by advanced computational methods, can open new paths for solutions in biology and medicine, e.g. for early detection, prevention and monitoring of disease evolution. The talk further shows new classes of imaging systems and sensors for assessing biochemical and pathophysiological parameters of systemic diseases, complement knowledge from –omic analytics and drive integrated solutions for improving healthcare.

M4-W2
15:30–16:00

Prof. Markus Schmidt
Leibniz Institute of Photonic Technology (Germany)

Optofluidic Microstructured Fibers:
Exploring Nanoparticle Dynamics via Tracking Analysis

High-speed tracking of single nano-objects provides key insights into nanoscale processes. This talk showcases advancements in tracking individual particles and ensembles within optofluidic microstructured optical fibers using elastic light scattering. Nano-objects are dispersed in liquid within a selected fiber channel. Light propagating through the fiber scatters at the diffusing nano-objects and is detected transversely with a microscope. Statistical trajectory analysis reveals diffusion properties and particle diameters with high accuracy.

I will outline the principles of this approach and highlight key findings. Specifically, I will demonstrate the retrieval of 3D trajectories of diffusing nanospheres and the simultaneous detection of hundreds of nano-objects in hollow anti-resonant fibers. Additionally, I will present data on the characterization of exceptionally small nanospheres (9 nm) and the precise identification of nanoparticle mixtures with close mean diameters. These results underscore the potential of optofluidic fiber platforms for nanoscale tracking and analysis.

M4 – W3 **Prof. Yuan Gong**
16:00–16:30 University of Electronic Science and Technology of China (China)

Fiber-Optic Microlaser Biosensors

The field of optical fiber biosensors has witnessed remarkable advancements and continues to offer significant opportunities for innovation. This presentation will focus on the development and application of fiber microlaser biosensors for the detection of protein biomarkers. The distinctive features of optical fibers and microlasers for biosensing will be analyzed. However, leveraging these features to achieve competitive performance in biosensing remains a considerable challenge.

Key mechanisms of fiber microcavity lasing and sensing will be discussed, alongside optimization strategies. These include, but are not limited to, comparisons between traveling-wave and standing-wave microcavities, the utilization of solid- versus solution-based gain materials, heterogeneous versus homogeneous bioconjugation, and intensity-based versus wavelength-based detection methods. Furthermore, two examples will be highlighted: sub-monolayer microlaser biosensors and homogeneous optofluidic laser biosensors. These examples will elucidate the tradeoffs in sensing performance, offering insights into the potential of this technology.

M5 Workshop B ***Technologies in Optical Fiber Sensing***

CHAIRS **Prof Satoshi Tanaka**
National Defense Academy (Japan)

Dr. Luis Rodrigue-Cobo
Universidad de Cantabria (Spain)

M5 – W1 **Dr. Linh Nguyen**
17:00–17:30 University of South Australia (Australia)

Sensing with Multimode Optical Fibers: A Machine Learning Perspective

In multimode optical fibers, the light confined in each mode has slightly different sensitivities to surrounding parameters, be it temperature, strain, or refractive index of the ambient environment (cladding). When used for sensing a specific parameter, multimode fibers can be viewed as the co-location of many slightly different sensors in both time and space. However, the cross-sensitivity from other parameters will lead to a different standard deviation for each sensing mode. Those parameter-specific estimations can be combined to produce a measurement with a much smaller variance by applying machine learning techniques on the entire multimode data.

I will discuss the principle behind the application of machine learning to multimode fiber sensing, with emphasis on sensing under very strong cross-perturbations and distributed sensing. The probabilistic nature of machine learning and its consequences on laboratory-based sensing experiments will be discussed. Perspectives on the future of using machine learning in conjunction with multimode fiber sensing in real-world applications will be presented.

17:30–18:00 **Prof. Cristiano Cordeiro**
Universidade Estadual de Campinas / (UNICAMP), Campinas (Brazil)

M5 – W2 ***Innovative Platforms for Optical Sensing: Hollow-Core and Biodegradable Optical Fibers***

IWe will discuss the investigation of specialty optical fibers with innovative structures, focusing on our current research efforts with hollow-core and biodegradable fibers for sensing applications. Recent advancements in hollow-core photonic crystal fibers have led to the development of low-loss fibers with simplified cross-sectional designs. Our research has focused on utilizing these fibers as sensing platforms, exploring applications in directional curvature, high-temperature, strain, and displacement sensors. By tuning their properties through asymmetric profiles, exploring core-cladding mode coupling, and incorporating additional materials, these fibers show promising capabilities for optical sensing.

In contrast, biodegradable optical materials offer unique advantages, such as biochemical compatibility and safe interaction with living tissues. Unlike conventional glass and plastic fibers, bioresorbable materials are soft, free from sharp edges, and can be absorbed or excreted after use. Here, we highlight our recent work on agar-based optical devices, including lenses, slab waveguides, and optical fibers for pressure, displacement, electric current, and biochemical measurements. Agar, a versatile yet underexplored material in photonics, holds potential for developing environmentally friendly, biocompatible optical sensors.

M6 Welcome Reception

18:30–20:00

Tuesday May 27th 2025

Tu1 9:00–9:30 Opening Cerimony

Tu2 Plenary Session I

CHAIR **Prof Manuel Lopez-Amo Sainz**
Universidad Pública de Navarra (Spain)

Tu2.1 9:30–10:30 **Prof. Christian Degen**
ETH Zurich (Switzerland)

Quantum Sensors in Diamond: Technology and Applications

Diamond has emerged as a unique material for a variety of applications, both because it is very robust and because it has defects with interesting properties. One of these defects, the nitrogen-vacancy (NV) center, shows quantum behavior up to above room temperature. Our group is exploring diamond as a platform for realizing nanoscale sensors with exquisite sensitivities and new capabilities.

In this talk, I will introduce the concept of diamond-based quantum sensors. I will discuss the fabrication of diamond probes and their integration into plug-and-play sensor chips. I will also discuss current challenges in scanning probe microscopy (SPM) system integration. The talk will conclude with illustrative examples of applications in metrology of magnetism and currents at the nanometer scale.

Tu3 Session 11h00–13h00 *Distributed Sensing I*

CHAIRS **Dr. Kwanil Lee**
Korea Institute of Science and Technology (Republic of Korea)

Prof. Luca Palmieri
University degli Studi di Padova (Italy)

Tu3.1 11:00–11:30 INVITED **Prof. Miguel González Herráez**
Universidad de Alcalá (Spain)

Distributed Acoustic Sensing in Submarine Optical Fibers

Submarine optical fibers carry well above 98% of the international data traffic. Despite their strategic function, these cables are very fragile and unprotected. In this talk, I will show that Distributed Acoustic Sensing (DAS) can provide essential information for protecting these extremely vital routes of information. Moreover, I will demonstrate that DAS over these cables also has significant potential for geophysical monitoring on the ocean floor. This may be especially valuable in regions where the scarcity of geophysical instruments limits our ability to measure crucial phenomena related to our planet and climate change, such as water mixing and stratification. In addition, I will discuss the potential for leveraging sensing information obtained in these cables to enhance tsunami early warning systems in vulnerable regions.

Tu3.2 11:30–11:45 ***Polarization pulling in Brillouin fiber sensing using orthogonal probes***

Moshe Tur*[a], Jonathan Bohbot[a], Luc Thévenaz[b], Marcelo A. Soto[c]; [a]School of Electrical Engineering, Tel Aviv University, Ramat Aviv 69978, Israel; [b]EPFL Swiss Federal Institute of Technology, Inst. ELE, SCI STI LT, 1015 Lausanne, Switzerland; [c]Dept. of Elect. Engineering, Universidad Técnica Federico Santa María, 2390123 Valparaíso, Chile. *tur@tauex.tau.ac.il

While birefringence-induced polarization fading in dual-probe Brillouin optical time-domain analysis has been demonstrated to be mitigated by using sub-mW orthogonally polarized probes, this work investigates consequences of using stronger probes. Experiments and simulations show that with probe powers of only a few mW and depending on the initial states of polarization (SOP) of the three waves (pump and dual probes), the Brillouin gain trace for kilometers long fibers may deviate from the expected attenuation-dictated exponential decay: sometimes dipping below and then almost always rising above this shape, indicating pump power amplification toward the fiber-end. Pump depletion may not be compensated either. Furthermore, Brillouin-induced strong polarization forces appear to play an important role in the process by pulling the SOP of the pump pulse towards the conjugate of the SOP of the launched loss probe (i.e., towards its reflected image by the equatorial plane of the Poincare sphere). Implications of these observations are also discussed

Tu3.3 11:45–12:00 ***Microcomb-enhanced BOTDR***

Jianting Li, Kezhao Gao, Mingming Nie, Junting Du, Xiangyang Lu, Zhaoyu Li, Teng Tan, Baicheng Yao, Yunjiang Rao*, Bowen Li*; Fiber Optics Research Center, Key Laboratory of Optical Fiber Sensing and Communications, University of Electronic Science and Technology of China, Chengdu 611731, China. *bowen.li@uestc.edu.cn; *yjrao@uestc.edu.cn

In this work, we propose, for the first time, a novel BOTDR concept based on optical microcomb, by leveraging its outstanding advantage of frequency multiplexing. Through theoretical analysis and simulations, we found that modulation instability (MI) is the major source of crosstalk between the microcomb lines and the increase in noise during the transmission of the microcomb. Therefore, a strategy called spectral-temporal interleaving (STI) is proposed and demonstrated to solve the problem, leading to a significant improvement in the SNR of Brillouin signals and, hence the performances of the BOTDR. It is verified by experiments that such microcomb-enhanced BOTDR can achieve a temperature measurement accuracy of 0.095°C, which is more than one order of magnitude higher than that of a generally conventional BOTDR with a single-frequency laser source. This technique will benefit all the distributed optical fiber sensing technologies based on Brillouin backscattering effects, such as BOTDR, BOTDA, etc.

Tu3.4 12:00–12:15 ***High-spatial-resolution distributed Brillouin sensing in plastic optical fibers: detection of 5 cm heated region***

Shimbu Shirai[a], Seiga Ochi[a], Keita Kikuchi[b], Shuto Tsurugai[b], Heeyoung Lee[b], and Yosuke Mizuno[a,c]; [a]Faculty of Engineering, Yokohama National University, Yokohama 240-8501, Japan; [b]Graduate School of Engineering and Science, Shibaura Institute of Technology, Tokyo 135-8548, Japan; [c]Institute of Multidisciplinary Sciences, Yokohama National University, Yokohama 240-8501, Japan

We propose and experimentally validate a strategy to enhance the spatial resolution of Brillouin optical correlation-domain reflectometry (BOCDR) in perfluorinated graded-index plastic optical fibers (POFs). By precisely accounting for the refractive index mismatch between silica and plastic fibers, we derive an optimized modulation amplitude that exceeds the conventional limit imposed by Rayleigh noise. Using this approach, we successfully detect a 5.0-cm heated section along a POF at a nominal spatial resolution of 4.4 cm, representing the highest value reported to date.

Tu3.5 12:15–12:30 ***Temperature sensing based on forward stimulated Brillouin scattering using high-order optical modes in few-mode fibers***

Yichun Li[a], Liang Zhang[a], Yu Chen[a], Heming Wei[a], Mengshi Zhu[a], Yunqi Liu[a], Fufei Pang[a], Tingyun Wang[a], Marcelo A. Soto[b]; [a]Key Laboratory of Specialty Fiber Optics and Optical Access Networks, Shanghai University, Shanghai 200444, China; [b]Department of Electronics Engineering, Universidad Técnica Federico Santa María, Valparaíso 2390123, Chile

This paper proposes and investigates a temperature sensing approach using forward stimulated Brillouin scattering (FSBS) activated by high-order optical modes (HOMs) in four-mode fibers. Experimental and simulation results demonstrate that high-order guided acoustic modes associated with HOMs are significantly enhanced in few-mode fibers (FMFs) compared to single-mode fibers. The increased amplitude of these guided acoustic modes, along with their larger temperature sensitivity, provides an improved temperature resolution for FSBS-based temperature sensing in FMFs. This research not only contributes to a better understanding of FSBS in FMFs but also opens new avenues for developing high-performance temperature sensors in FMFs using a sub-GHz frequency scan for a wide range of applications.

Tu3.6 12:30–12:45 ***DAS with 302 km sensing range using remote amplification and engineered fiber***

Erlend Rønnekleiv[a], Jan Kristoffer Brenne*[a], Trygve Sørgård[a], Ole Henrik Waagaard[a], Nikolai Tolstik[a], Dmitry Klimentov[a], Timothy Lee[b], Martynas Beresna[b], Gilberto Brambilla[b];[a]Alcatel Submarine Networks Norway, Vestre Rosten 77, 7075 Tiller, Norway; [b]Optoelectronics Research Centre, University of Southampton, Southampton, SO17 1BJ, UK. *jan.kristoffer.brenne@asn.com

We demonstrate extended sensing range of DAS for passive, unrepeatered fiber networks with single-end access. The frequency swept interrogation technique, capable of 154 km DAS sensing range in standard telecom fibers, is taken as the basis for our experiments. Raman amplification is found to extend the sensing range to 202 km, while adding a ROPA to the line further extends the range to 254 km. We also discuss the utilization of engineered fiber for extended sensing range and demonstrate DAS measurements with engineered fiber positioned at 302 km. Based on our results we estimate that a low-loss engineered fiber with gradually increased reflectivity could facilitate interrogation noise below ~30 pε/√Hz throughout the complete 300 km range.

Tu3.7 12:45–13:00 ***Quasi-distributed acoustic sensing with DSB-OFDR for large measurement range and enhanced frequency response***

Rongrong Niu[a], Qingwen Liu*[a], Yanming Chang[a], and Zuyuan He[a]; [a]State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong University, Shanghai 200240, China

We demonstrate a quasi-distributed acoustic sensor with a large measurement range and high-frequency response, based on time-frequency-multiplexing double-sideband optical frequency domain reflectometry (TFM-DSB-OFDR) and an ultra-weak chirped fiber Bragg grating (UWCFBG) array. The Doppler frequency method detects vibration signals by measuring Doppler shifts caused by vibrations, enabling detection of signals with exceptionally large amplitudes. Combined with the time-frequency multiplexing scheme, the system's frequency response is enhanced. In the experiment, the system achieves a sampling rate of 500 kHz, a 50-fold increase.

Tu4 Session
14h30–16h00

New Elements, Effects, or Technologies and Materials for Photonic Sensing

CHAIRS

Prof. Sylvain Girard
University Jean Monnet Saint-Etienne (France)

Dr. Ali Masoudi
University of Southampton (United Kingdom)

Tu4.1 14:30–15:00
INVITED

Prof. Lan Yang
Washington University (United States of America)

Whispering-Gallery Microresonators Sensors: Fundamentals and Applications

Sensors play crucial roles in biomedical research, clinical diagnosis, food safety, pharmaceutical testing, and environmental monitoring. Among them, optical sensors based on whispering-gallery-mode (WGM) resonators have emerged as front-runners for sensing applications due to their exceptional capability to significantly enhance light-matter interactions. This talk will introduce ultra-high-quality (Q) optical WGM microresonators and the diverse sensing mechanisms and strategies developed around them. Various strategies, such as a self-referenced mode-splitting technique for size measurement of nanoparticles, mechanical solitons through optomechanical effects in a microtoroid resonator, a barcode technology based on collective behaviors of multiple resonances, and AI-enhanced label-free classification of free-flowing nanoparticles and cells through photoacoustic signatures, will be introduced. Recent investigations into fundamental physics, particularly light-matter interactions around exceptional points (EPs) in WGM resonators, have unraveled innovative strategies to achieve a new generation of optical systems. A novel strategy to extend EP-enhanced sensing to a wide range of optical sensor systems will be presented. This talk will elucidate the transformative potential of WGM resonators in advancing the field of optical sensing technologies.

Tu4.2 15:00–15:15

Plasmonic tilted fiber Bragg grating sensors: insights into their effective demodulation

Hadrien Fasseaux[a], Médéric Loyez[b], Christophe Caucheteur*[a]; [a]Advanced Photonic Sensors Unit, University of Mons, Boulevard Dolez 31, 7000 Mons (Belgium); *Christophe.CAUCHETEUR@umons.ac.be

Plasmonic tilted fiber Bragg gratings serve as highly sensitive refractometers and biosensors. This study compares four demodulation methods, highlighting a filtering-based approach that improves linearity and simplifies spectral interpretation. The method is validated through the detection of clinically relevant concentrations of C-reactive proteins, showcasing its potential for biomedical and environmental applications.

Tu4.3 15:15–15:30 ***Enhancing a polarimetric fiber sensor using Fisher information***

Tiago D. Ferreira[a,b], Catarina Monteiro[a,b], Carolina Gonçalves[a,b], Orlando Frazão[a,b], Nuno A. Silva[a,b]; [a]INESC TEC, Centre of Applied Photonics, Rua do Campo Alegre 687, 4169-007 Porto, Portugal; [b]Departamento de Física e Astronomia, Faculdade de Ciências, Universidade do Porto, Rua do Campo Alegre s/n, 4169-007 Porto, Portugal

Polarization-based fiber sensors rely on the dynamics of the Stokes vector at the output of the optical fiber to probe stimuli that induce polarization variations. However, these sensors often suffer from limitations in sensitivity, precision, and reproducibility. In this work, we address these challenges by incorporating concepts from the Mueller matrix formalism to enhance the capabilities of such sensors. Specifically, we measure the Mueller matrix in the polarization basis that describes how the polarization evolves inside the optical fiber. Leveraging this formalism, we configure the system as a precise sensor to detect deformations along the fiber. By utilizing the Fisher Information framework, we significantly improve accuracy and resolution, enabling the detection of subtle perturbations with greater precision. This study introduces a novel approach for precise polarization control and advanced fiber-based sensing applications.

Tu4.4 15:30–15:45 ***Control of Bragg wavelength drift in high temperature annealing cycles for RFBGs and fs-FBGs***

Karima Chah[a*], Damien Kinet[a,b], Maria Traianidis[c], Corentin Guyot[b], Christophe Caucheteur[a]; [a]University of Mons, Electromagnetism and Telecommunication Department, 31 Boulevard Dolez, 7000 Mons, Belgium; [b]B-SENS SRL, 31 Boulevard Dolez, 7000 Mons, Belgium; [c]Belgian Ceramic Research Centre - BCRC Av. du Gouverneur Emile Cornez 4, 7000 Mons, Belgium. *karima.chah@umons.ac.be

For harsh environment applications (corrosion, high temperature (HT)) particular attention was paid toward developing Fiber Bragg Gratings (FBGs)-based sensors with improved thermal properties. Two mean solutions are proposed: regenerated FBGs (RFBGs) and FBGs produced by direct femtosecond pulses laser methods (fs-FBGs). Extended exposure of these gratings to HT can lead to the optical fiber's structural changes, modification of the mechanical properties, and a drift in the Bragg wavelength, which affects the sensor's long-term accuracy [5]. In this study, We investigate the regeneration process of FBGs in standard fused silica glass encapsulated in sealed and unsealed tubes with air and Argon. Then we subject both RFBGs and Fs-FBGs to several high temperature cycling to study the Bragg wavelength drift. We show that the regeneration occurs only in air or unsealed tubes and the RFBGs show less drift than fs-FBGs during the post-annealing process in small diameter tubes (1mm).

Tu4.5 15:45–16:00 ***Natural scene images reconstruction based on multimode fiber***

Mengyao Zhang[a,b], Wei Jin[a,b], Jiaxing Gao[a,b], Jinhua Mou[a,b], Shanshan Li[a,b], Yu Zhang*[a,b], Zhihai Liu*[a,b]; [a]Key Laboratory of In-Fiber Integrated Optics, Ministry of Education, Harbin Engineering University, Harbin, 150001, P. R. China; [b]Key Laboratory of Photonic Materials and Device Physics for Oceanic Applications, Ministry of Industry and Information Technology of China, Harbin Engineering University, Harbin, 150001, P. R. China.

High fidelity natural scene image reconstruction in the multimode fiber (MMF) imaging remains an outstanding challenge. We present a MMF imaging based on bit-plane encoding for the higher quality natural scene imaging. Compared to conventional method, the average SSIM for bit-plane encoding improves by approximately 0.04. We achieve an SSIM of 0.575 with only two higher-order speckles, and it is about 11.76 times faster than traditional methods.

Tu5 Session *Distributed Sensing II*

16h30 – 17h30

CHAIRS

Prof. Yun-Jiang Rao
University of Electronics Science and Technology of China (China)

Prof. Avishay Eyal
Tel Aviv University (Israel)

Tu5.1 16:30 – 17:00
INVITED

Dr. Miguel Soriano Amat
RISE (Sweden)

Time-Expansion Concept in Distributed Sensing

Time-expansion technology has emerged as a promising approach to enhance the spatial resolution of time-resolved distributed fiber sensing systems. By leveraging dual-frequency comb concepts, this technique enables a customized temporal expansion of retrieved traces, reducing detection requirements and improving efficiency. This method overcomes the conventional high-bandwidth detection limitations of centimeter-scale resolution systems while maximizing optical SNR and simplifying post-processing. In this contribution, we review the latest advancements in time-expansion technology, including SNR optimization and improvements in QIR configurations, and expose interesting applications of the technology, such as distributed and dynamic shape sensing

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Tu5.2 17:00 – 17:15

Ambient noise interferometry using Chirped-Pulse DAS data for subsurface exploration

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This study demonstrates the potential of Chirped-Pulse Distributed Acoustic Sensing (DAS) technology for subsurface imaging through the application of Ambient Noise Interferometry (ANI). By analyzing strain data, we successfully extracted geological insights without relying on active seismic sources. The low-intensity signals were isolated and enhanced using ANI techniques such as FK filtering, temporal normalization, and spectral whitening. Using a custom ANI algorithm, velocity dispersion maps were generated from 24 hours of continuous DAS recordings. These maps revealed dispersion relationships corresponding to different terrain layers. The methodology employed, including Phase-Weighted Stacking and slant-stacking, proved effective for reducing noise and isolating surface wave propagation signals within the frequency range of 0.5–15 Hz. This versatile and cost-effective approach is well-suited for high-resolution, non-invasive subsurface imaging in diverse environments, from submarine cables to urban settings.

Tu5.3 17:15–17:30 ***Absolute temperature sensing in the 67-350 K range using Brillouin scattering in gases***

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This paper proposes a novel temperature sensing method using stimulated Brillouin scattering in a hollow-core fiber filled with gas. Compared to classical Brillouin sensors, the Brillouin response of gases shows a higher sensitivity at cryogenic temperatures and a null sensitivity to strain. Experimental results demonstrate that argon is highly efficient for ambient temperature sensing, providing a 2.4-fold gain coefficient compared to silica fibers. Meanwhile, neon proves ideal for cryogenic sensing, offering a potential gain coefficient at 77 K that is twice that of silica fibers at ambient temperature.

Tu6 Poster Session I

17h30–19h00

Distributed/Multiplexing/Physical Sensors

Tu6.1 17:30–19:00 ***σ-BOTDA: exploiting frequency symmetry in Brillouin sensors***

Sébastien Le Floch, Florian Sauser; Haute Ecole ARC Ingénierie (University of Applied Sciences of Western Switzerland), Espace de l'Europe 11, 2000 Neuchâtel, Switzerland

We propose a new, simplified Brillouin Optical Time-Domain Analyzer that takes full advantage of frequency-symmetrical signals by measuring the dispersion of the probe power thanks to orthogonal polarizations of the dual-pump or probe. This new BOTDA can be configured as a dual-pump or dual-probe system.

Tu6.2 17:30–19:00 ***An investigation of Rayleigh backscattering: utilizing coherent laser sources for enhanced IFOG performance***

Rizwan Zahoor[1*], Ferdinando D'Apice[1], Marialuisa Capezzuto[1,2], Fabrizio Sgobba[1,3], Davide D'Ambrosio[1], Paolo De Natale[4], Gianluca Gagliardi[1], Luigi Santamaria Amato[3] and Saverio Avino[1];[1]Consiglio Nazionale delle Ricerche, Istituto Nazionale di Ottica (INO), via Campi Flegrei, 34 Comprensorio A. Olivetti, I-80078 Pozzuoli, Italy; [2]Dipartimento di Matematica e Fisica, Università della Campania 'Luigi Vanvitelli, Caserta, Italy; [3]Agenzia Spaziale Italiana, Centro di Geodesia Spaziale 'Giuseppe Colombo, Località Terlecchia, 75100 Matera, Italy; [4]Consiglio Nazionale delle Ricerche, Istituto Nazionale di Ottica (INO), Largo E. Fermi 6, 50125 Firenze, Italy.

Interferometric fiber-optic gyroscopes (IFOGs) are usually interrogated by broadband incoherent light sources instead of narrow linewidth coherent lasers. One of the main reasons is the problem of Rayleigh backscattering into the fiber, whose components sum up coherently for lasers and incoherently for broadband sources. In this work we investigate the possibility to use an amplitude modulated laser for interrogating an IFOG, which brings to a strong Rayleigh backscattering noise suppression. For this purpose, light is sent as short pulses of 1.86 µs width and 18.6 µs period in a 2-km fiber loop, which ensures the least temporal overlap between the forward-propagating and backscattered light. This technique reduces the cumulative backscattered power and its negative effect on system performance. The experimental investigation into pulse modulation presented here clearly demonstrate that pulse modulation improves stability and precision up to an order of magnitude, with critical timescales of noise levels lowered by a factor of ten, improving the performance of IFOG systems.

Tu6.3 17:30–19:00 ***Semi-distributed optical fiber bending extensometer system for precision landslide monitoring based on OTDR***

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A semi-distributed optical fiber bending extensometer system based on OTDR is proposed, consisting of N-loops designed to enable different maximum extension measurements and sensitivities. This system offers a low-cost solution for monitoring landslides and similar civil structures. Tests conducted at 1625 nm demonstrate that different series of sensors can be independently measured with elongation errors typically within ±0.25 cm across a range from 0 to 9 cm.

Tu6.4 17:30–19:00 ***Broad-bandwidth distributed acoustic sensor with phase offset and phase sensitivity fading compensation***

Jiazhen Ji[a], Jiageng Chen*[a], Zhengyuan Xiao[a], Zhengwen Li[a], Jingdong Zhang[b], Shengwen Feng[b], Feng Li[b], Qingwen Liu[a], Zuyuan He[a] ; [a]State Key Laboratory of Advanced Optical Communication System and Networks, Shanghai Jiao Tong University, Shanghai 200240, China; [b]Huawei Technologies Company, Ltd., Shenzhen 518129, China. *ji.jiazhen@sjtu.edu.cn; jiagengchen@sjtu.edu.cn.

The phase offset and phase sensitivity fading effect is a major concern in broad-bandwidth distributed acoustic sensor (DAS) or frequency-division multiplexed phase-sensitive optical time-domain reflectometry (FDM Φ-OTDR). In this work, we improve the fading compensation approach one step further, from employing single reference frequency component, to using two FDM pulse trains whose frequency component numbers are different. Correspondingly, the solution method of offset and sensitivity coefficients is changed from linear fitting to solving matrix equation. This compensation approach can effectively suppress the spurious frequencies in FDM Φ-OTDR measurement results.

Tu6.5 17:30–19:00 ***High thermal-stability Fabry-Perot acoustic sensor with graphene diaphragm***

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Although graphene-based Fabry-Perot (F-P) acoustic sensor demonstrates superior performance in terms of high sensitivity and compact size, temperature fluctuation remains a challenge affecting its cavity length and sensitivity. Here, a simple and portable graphene-based F-P acoustic sensor with quartz cavity structure (QCS) is developed to achieve a significantly decreased cavity length change of 3.1 nm/°C in the tested range of 20–80 °C, 95 times smaller than a referenced acoustic sensor with ceramic cavity structure (CCS). The sensitivity variation at typical 1 kHz is reduced to 0.46 %/°C, 2.3 times smaller than the result for the latter. Moreover, the maximum voltage sensitivity at 20 °C is up to 10.65 V/Pa@17 kHz in the range of 0.1–18 kHz, which is remarkably superior to the state-of-the-art F-P acoustic sensors reported previously. The device with temperature compensation exhibits potential applications in aerospace and emergency rescue requiring weak acoustic detection in harsh environments.

Tu6.6 17:30–19:00 ***Fiber Fabry-Perot interferometer sensor for dynamic magnetic field detection based on microwave photonic filter***

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A novel fiber Fabry-Perot interferometer (FPI)-based sensing system for dynamic magnetic field detection is proposed and experimentally demonstrated. The FPI is composed of a reflector and a cleaved end face of a single mode fiber, and is fixed on a giant magnetostrictive rod. The significant length change of the FPI cavity caused by external dynamic magnetic field is interrogated by a microwave photonic filter (MPF) system, in which the phase shift of a single-frequency electrical signal within the passband of the MPF is utilized and recorded. Experimental results show that the magnetic field sensitivity and minimum detectable magnetic field reach up to 4.13 × 10-4 rad/μT and 1.36 μT/Hz1/2 respectively.

Tu6.7 17:30–19:00 ***Parallel data transmission using modulated vibration and MachZehnder interferometer***

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In this study, we reveal the distinct frequency response of optical cables and internal fibers, and provide insight into parallel data transmission using modulated vibrating signals and Mach–Zehnder interferometers configured within optical cables. The results highlight the importance of selecting the appropriate vibration frequency for internal fibers. In addition, the results of evaluating the bit error rate characteristics of parallel data transmission using two carrier frequencies indicate that for reliable parallel data transmission, it is important to select carrier frequencies that are not affected by crosstalk.

Tu6.8 17:30–19:00 ***Chitosan-ion-imprinted polymer-based Mach-Zehnder interferometer sensors for Cd $^{2+}$ detection using cross-linking polymerization***

Xujie Wang*[a], Abdullah Al Noma[b] and Changyuan Yu[a];[a]Photonics Research Center, Department of Electronic and Electrical Engineering, The Hong Kong Polytechnic University, Hong Kong SAR, China, 999077; [b]Department of Electronic and Computer Engineering,

A Mach-Zehnder interferometer (MZI) based fiber optic sensor for the detection of cadmium ions (Cd^{2+}) using chitosan-ion imprinted polymer (CS-Cd^{2+}IP) coatings is presented here. The proposed sensor employs a multimode and no-core fiber (MMF and NCF) spliced between single-mode fibers (SMFs). The sensitivity of the MZI sensor is enhanced by crosslinking the chitosan polymer with epichlorohydrin (ECH) at different concentrations, forming a polymer network. The sensors exhibit varying sensitivity and selectivity ranges depending on the ECH concentration, with probe 1 achieving a range of 0 to 1 ppb (parts per billion), probe 2 from 0.01 ppb to 10 ppb, and probe 3 from 1000 ppb onwards.

Tu6.9 17:30–19:00 ***Enhanced multi-branch sensing by leveraging the Fresnel reflection points in phase-sensitive OTDR-based PON monitoring***

Maoqi Liu[a,b], Jingchuan Wang[b],*, Chen Liu[a], Luming Zhao[a], Changyuan Yu[b], and Chao Lu[b] ;[a]School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan 430074, China; [b]Photonics Research Institute, Department of Electrical and Electronic Engineering, The Hong Kong Polytechnic University, Hong Kong, China. *jingchuan98.wang@connect.polyu.hk

We achieve distributed sensing of the feeder link in passive optical networks employing a phase-sensitive optical time-domain reflectometer, while enhancing event monitoring by leveraging Fresnel reflections from fiber connectors in multiple branches to detect temperature changes, vibrations, breakpoints, and bends.

Tu6.10 17:30–19:00 ***High-fidelity vehicle sensing with swiftly deployed DAS system***

Yingqing Wu, Siyuan Peng, Ke Liu, Chunye Liu, Wangyouyou Li, Jie Li, Taichao Wang, Minglu Li, Yifei Qi, Zinan Wang*; Key Laboratory of Optical Fiber Sensing and Communications, University of Electronic Science and Technology of China, Chengdu 611731. *znwang@uestc.edu.cn

This study demonstrates the application of an in-house developed high-performance DAS for vehicle signal detection. High-fidelity vehicle signals are successfully captured, and their spectral characteristics are thoroughly analyzed. Signal clarity is further enhanced using an S-transform-based denoising method. Notably, common telecom cable freely layed over the road surface is used as the sensing medium, eliminating the need for complex coupling treatments, which enables rapid deployment. This work presents one of the highest-quality vehicle signals acquired by DAS under similar deployment conditions. Particularly, the vehicle wheelbase is directly extracted from the DAS signal, a capability that has not been reported in previous studies.

Tu6.11 17:30–19:00 ***Forward Brillouin scattering in few-mode fiber towards sensing***

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Forward Brillouin scattering is a nonlinear interaction between co-propagating optical waves and mechanical cladding modes. The effect has emerged as a new modality for fiber sensing of media beyond the cladding boundaries, where guided light cannot reach. Forward Brillouin scattering has been mostly examined over to single-mode fibers. Here we extend the study of forward Brillouin scattering to the few optical modes regime. We predict and observe the stimulation of new classes of mechanical cladding modes, with first-order and fourth-order azimuthal symmetries, which are inaccessible in single-mode fibers. The frequencies range of the process is extended to 1.8 GHz. We also report the stimulation of mechanical cladding modes above their cut-off frequencies, where they are not entirely transverse. Lastly, we demonstrate the detection of liquid outside the cladding of the few-mode fiber using the mechanical modes of first-order azimuthal symmetry, reached herein for the first time.

Tu6.12 17:30–19:00 ***The impact of chromatic dispersion on Frequency Scanning COTDR and its compensation***

Naoki Yamashiro, Yoshihiro Kanda, Kengo Koizumi, and Hitoshi Murai; Photonics R&D Department, R&D Center, Technology Division, Oki Electric Industry Co., Ltd, 1-16-8 Chuo, Warabi-shi, Saitama, 335-8510, Japan

Frequency Scanning COTDR is a promising technology for the maintenance and management of social infrastructures because of its capability to measure strain with high accuracy over long distance. In Frequency Scanning COTDR, Rayleigh scattering intensity is measured while the light source frequency is discretely varied. However, group velocity in optical fiber depends on the optical frequency. Therefore, as the measurement distance increases and the optical frequency range widens, the effect of chromatic dispersion is expected to become significant and degrade the measurement accuracy. However, to the best of our knowledge, this issue has not been thoroughly investigated. In this paper, we theoretically derived the impact of chromatic dispersion on Frequency Scanning COTDR and proposed its compensation method. We also experimentally demonstrated the impact of chromatic dispersion and the effectiveness of the proposed method. The results show that the proposed method effectively compensates for chromatic dispersion and improves the measurement accuracy.

Tu6.13 17:30–19:00 ***Extension of the measurable strain range in OFDR using overlapping and averaging method***

Riku Hiroto, Naoki Yamashiro, Kengo Koizumi, and Yoshihiro Kanda; Photonics R&D Department, R&D Center, Technology Division, Oki Electric Industry Co., Ltd., 1-16-8 Chuo, Warabi-shi, Saitama 335-8510, Japan

Optical Frequency Domain Reflectometry (OFDR) has been widely used for many applications thanks to its high strain accuracy and high spatial resolution. In OFDR, cross-correlation between reference and measured Rayleigh Scattering Spectrum (RSS) is calculated, and strain is obtained from the peak shift of the cross-correlation. As strain increases, the similarity between reference and measured RSS is degraded and correct calculation of the peak shift is consequently difficult. In this paper, to avoid such misdetection of correlation peak, we propose an algorithm that suppresses undesired correlation coefficients. In this method, multiple cross-correlations are calculated for overlapped sub-windows. The peak shift of the correlation is calculated based on the averaged of the cross-correlations over all sub-windows. Despite simple calculation, the ratio between true peak and undesired correlation coefficients is improved. In our experiments, the measurable range could be extended from 2,500 με to 4,500 με.

Tu6.14 17:30–19:00 ***Lightweight distributed vibration sensing algorithm boosted with cross-domain distillation***

Zhongyao Luo, Hao Wu*, Zhao Ge, Ming Tang; Wuhan National Laboratory for Opto-electronics, Next Generation Internet Access National Engineering Laboratory, and Hubei Optics Valley Laboratory, School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, China. *wuhaoboom@hust.edu.cn

We introduce a real-time processing solution for long-distance phi-OTDR distributed vibration sensing systems, leveraging an ultra-lightweight model enhanced with FPGA-based hardware acceleration and a novel cross-domain distillation technique. The proposed methods embed prior physical knowledge into the system, enabling significant improvements in efficiency, performance, and interpretability.

Tu6.15 17:30–19:00 ***Novel OFDR enhanced by dual-microcombs***

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Optical frequency combs offer groundbreaking tools for advanced metrology and sensing. The invention of microcombs promotes the practicality of optical frequency combs greatly. In this work, we propose and demonstrate a novel optical frequency domain reflectometer (OFDR) concept based on dual-microcombs. By combining dual-microcombs and tunable laser source, this novel OFDR can significantly enhance the strain sensitivity (up to 177.8 pε/√Hz) by a √N-fold (here N is the number of the microcomb lines used) via superposition of multi-frequency signals, while maintaining superior spatial resolution (under 0.82 mm) for precise localization and large response bandwidth (achieved 1 kHz). This work may lead to the realization of new OFDR that can achieve distributed dynamic sensing with high sensitivity, high spatial resolution and large bandwidth simultaneously.

Tu6.16 17:30–19:00 **BOTDR based on a self-sweeping fiber laser**

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Brillouin optical time domain reflectometry (BOTDR) systems are one of the most advanced types of distributed measurements. Typically, such systems involve the use of highly coherent tunable radiation, requiring electro-optical modulators and expensive microwave electronics elements. In this study, we present the first demonstration of a BOTDR system based on a self-sweeping fiber laser. Such lasers simplify generation of coherent tunable radiation because of passive wavelength tuning. So, the BOTDR system itself can be simplified by applying suitable self-sweeping fiber laser. We

used an Er-doped continuous-wave self-sweeping fiber laser with a sweeping step of 6.2 MHz and range of ~2.5 GHz near the wavelength of 1565.2 nm. The developed BOTDR system was used to measure the Brillouin frequency shift in a 25-km-long sensing line with spatial resolution of ~10 m. The here-proposed approach makes it possible to create less complicated and less expensive systems for distributed temperature and strain measurements.

Tu6.17 17:30–19:00 ***Distributed Brillouin measurement in graded index multimode optical fiber***

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We present distributed Brillouin measurements realized in a commercially available graded-index few mode optical fiber. The measurements were performed using a Brillouin Optical Time Domain Reflectometer instrument coupled with an industrial multiplexer designed for the multimode fiber, enabling the characterization of 15 Hermite-Gaussian modes of the multimode fiber. The low intermodal crosstalk observed allowed for reliable measurements even in the absence of the multiplexer. Preliminary results of temperature Brillouin frequency coefficient are also presented.

Tu6.18 17:30–19:00 ***Separation of temperature and strain measurement in photon-counting BOTDR***

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This paper presents a photon-counting v-BOTDR system that separates temperature and strain effects along an optical fiber. By using different working points of a fiber Bragg grating (FBG), the system tunes its sensitivity to these variations. The technique enables accurate frequency shift measurements, unaffected by optical losses or intensity fluctuations. Experimental results show the system can distinguish temperature and strain variations over 50 km with 2 m spatial resolution using standard single-mode fiber.

Tu6.19 17:30–19:00 ***Characterization of heterogeneously integrated periodically-polled lithium niobate using optical frequency-domain reflectometry***

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Photonic integrated periodically poled lithium niobate (PPLN) has emerged as one of the most promising photonic devices for both classical and quantum applications, thanks to its efficient nonlinear optical processing capabilities. However, the characterization of such integrated device has been barely studied, particularly regarding reflection properties arising from coupling facets. Here, we present the successful integration of a wavelength conversion module using a PPLN by integrating two platform technologies: silicon nitride and lithium niobate. The module features 5 mm-long periodically poled waveguides on lithium niobate, designed for wavelength up-conversion from 1560 nm to 780 nm via second harmonic generation. The PPLN waveguides are packaged with silicon nitride interposers for edge coupling mode size conversion to an optical fiber array. To characterize reflection profiles along the fabricated device, an OFDR at 1560 nm with a spatial resolution of 1.5 mm in air at 100 Hz is used. The sensing system enables analysis of reflections potentially caused by refractive index mismatching at the coupling facets and by micro-structured periodic domain inversion within the PPLN.

Tu6.20 17:30–19:00 ***A modal interferometer-based wearable system for health monitoring***

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Sensitive wearable systems for vital physiological parameters monitoring, such as body temperature and pulse rate, have gained significance for personalized and public healthcare. Here, we propose and demonstrate a flexible and wearable modal interferometer based on photonic crystal fiber (PCF) embedded in a polydimethylsiloxane (PDMS) membrane for accurate pulse rate monitoring. The system depicts the sensitivity of 283 pm/oC for the temperature variation. The stretching sensitivity of the proposed sensor is observed to be 2.6 pm/um over a range of 0 – 2000 um. The proposed system facilitates body temperature and pulse rate detection with high accuracy and repeatability. This system has the potential to act as a wearable device for extensive bio-medical applications.

Tu6.21 17:30–19:00 ***Mitigation of nonlocal polarization effect in Φ-OTDR using MIMO technique***

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We report on the nonlocal polarization effect in phase-sensitive optical time-domain reflectometry (Φ-OTDR) systems. The polarization state of the probe light evolves along the fiber as the probe pulse passes through the disturbed fiber region. Simulation and experimental results reveal that significant rotation of the local state of polarization imposes a nonlocal polarization-related phase noise on the subsequent sensing signal. To mitigate this nonlocal polarization effect, we propose the use of orthogonal polarization division multiplexed optical pulses to implement a multi-input and multi-output (MIMO) scheme. In both simulations and experiments, the polarization-division-based MIMO system is demonstrated to be immune to the nonlocal effect, even under extreme conditions.

Tu6.22 17:30–19:00 ***Optical flow processing for chirped-pulse coherent OTDR***

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We propose a novel optical flow processing technique for distributed temperature and strain sensing with the chirped-pulse coherent OTDR. Unlike conventional 1-dimensional cross-correlation methods, the technique treats the 2-dimensional waterfall data as sequential video frames, estimating local shifts through optical flow. The weighted least square approach with adaptive window size enables pixel-level optical flow calculation, providing accurate local shifts via accumulative tracks with enhanced spatial resolution. Preliminary experimental results over 20km fiber demonstrate its effectiveness for dynamic temperature and strain sensing, addressing limitations of traditional methods and improving sensing capabilities.

Tu6.23 17:30–19:00 ***Compact highly-sensitive device based on interference-whispering gallery mode composite structure***

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A composite whispering gallery mode (WGM) sensor integrating nonadiabatic tapered optical fiber interference (NTFI) was first proposed and fabricated for humidity sensing applications. The microbottle resonator is a compact, composite all-fiber optic sensor manufactured by coupling a polyvinyl alcohol (PVA)-coated hollow core fiber (HCF) with a nonadiabatic tapered single mode fiber (SMF).

Rather than merely connecting interferomece strutrue and WGM cavity in series, the sensor exploits interference and WGM resonance within the same optical fiber pathway, which has the advantages of extremely high detection limit and resolution advantages. Experimental results demonstrate that the composite sensor possesses a humidity sensitivity of -59.9 pm/%RH. Compared with the traditional cascade microcavity, the sensor boasts advantages including simple fabrication, low cost, compact size, and excellent stability, rendering it highly beneficial for diverse practical applications, notably in concentration measurements.

Tu6.24 17:30–19:00 ***High-precision fabrication method for Fabry-Perot cavities using white light interferometry***

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This work presents a method for fabricating multiple identical Fabry-Perot cavities using White Light Interferometry (WLI) to monitor the length tuning of the structure in real time. This fabrication approach enables the actual optical path difference to be tracked during the process, utilizing the same interrogator intended for sensor operation. As a proof of concept, three identical cavities were successfully fabricated. These cavities were confirmed to be identical using the WLI system and were further characterized by measuring their dimensions under a microscope. This technique enabled the production of three Fabry-Perot cavities with a measured length of 499.60±0.01 µm.

Tu6.25 17:30–19:00 ***Analysis and compensation for the impact of modulation signal reset errors on scale factor of interferometric fiber optic gyroscopes***

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Interferometric fiber optic gyroscopes (IFOGs) function as rotation rate sensors that operate based on the Sagnac effect. Currently, the digital closed-loop detection scheme is widely utilized worldwide. However, environmental disturbances can induce reset errors during the modulation signal reset. This paper examines the impact of modulation signal reset errors on the scale factor of IFOGs, and derives a quantitative relationship between reset errors and inaccuracies in the scale factor. The analysis reveals that modulation signal reset errors do not affect the asymmetry or nonlinearity of the scale factor; rather, they solely impact the reproducibility. By leveraging the relationship model between 2π-phase voltage and the temperature of the lithium niobate modulator, this paper proposes an effective compensation method to address modulation signal reset errors, thereby overcoming the limitations associated with traditional second closed-loop systems under conditions of high dynamics and low-speed input.

Tu6.26 17:30–19:00 ***Extending the measurement range of Brillouin optical correlation domain analysis through asymmetric adjustment of Stokes and anti-Stokes intensities***

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We present a significant advancement in Time-Domain Brillouin Optical Correlation Domain Analysis (TD-BOCDA) technology by exploiting the intensity imbalance between Stokes and anti-Stokes components in the Brillouin probe wave. Through a systematic comparison of Brillouin frequency distributions under various sideband modulation conditions, we have successfully extended the measurement range of the TD-BOCDA system. Notably, we achieved a 50 km measurement range with a high spatial resolution of 7 cm without the need for optical amplification. This remarkable performance was attained by optimizing the intensity difference between Stokes and anti-Stokes components to 7 dB.

Tu6.27 17:30–19:00 ***Dual closed-loop detection scheme for differential FOG driven by dual sources***

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An all digital dual closed-loop detection scheme for the differential fiber optic gyros driven by dual sources (DS-DFOG) is proposed and demonstrated experimentally. A DS-DFOG prototype is developed and the stable scale factor is achieved. The temperature experiment results show that the drift introduced by rapid temperature changes has almost been suppressed, and its bias instability is reduced by more than an order of magnitude compared to the single equivalent FOGs.

Tu6.28 17:30–19:00 ***Short-time Fourier neural operator for self-extraction of data feature in distributed acoustic sensing***

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Event recognition in distributed acoustic sensing (DAS) applications faces challenges due to intense environmental noise and complex signal features. We propose short-time Fourier neural operator to self extract the temporal and frequency domain features of DAS data for event recognition performance enchancement.

Tu6.29 17:30–19:00 ***A vibration sensor with four channels utilizing an in-line Sagnac interference structure***

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A four-channel vibration sensor was developed based on an in-line Sagnac interferometer. This article introduces a configuration of the in-line Sagnac interferometer, a Lyot fiber depolarizer, and a demodulation method utilizing a 3×3 coupler. The integration of the Lyot depolarizer significantly reduced polarization fading. By employing both single-channel and multi-channel Dense Wavelength Division Multiplexing, simultaneous four-channel sensing was achieved. Each channel demonstrated high sensitivity to vibration, with a single channel reaching a sensitivity of 10.1591 rad/(m/s²), and the resolution can be calculated to be 2.2×10-6 m/s2 This method effectively lowered costs and eliminated signal crosstalk, offering a partial solution to the challenge of accurately locating intrusion points in fiber optic vibration monitoring systems.

Tu6.30 17:30–19:00 ***Dual-stage modulation correlation OTDR for high-resolution monitoring in passive Optical network***

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Utilizing correlation detection and dual-stage modulation, we detected reflected signals at -56.3 dBm with less than 10 cm spatial resolution in typical PON scenarios. The correlation OTDR achieves higher SNR with less computational cost, enabling optical power monitoring and fault diagnosis for each branch.

Tu6.31 17:30–19:00 ***Distributed humidity measurements using fibre-segment interferometry***

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A novel approach to distributed humidity sensing using polyimide-coated optical fibres and fibre segment interferometry (FSI) is demonstrated. FSI interrogates the cumulative strain along fibre segments formed between pairs of ultrashort FBG reflectors, with measurement sensitivity scaling with segment length. Polyimide, a hygroscopic coating material, induces strain on the optical fibre in response to humidity changes. Experiments were conducted using a serial array of fibre segment interferometers, comprising three 10 mm long fibre segments, with polyimide coatings on two segments and the third uncoated for control. The polyimide-coated segments exhibit strong and consistent phase responses to changes in relative humidity (RH), with responsivities of 0.049±0.05 rad/mm/%RH and 0.043±0.05 rad/mm/%RH, respectively over the 30% RH range tested. The uncoated segment displayed no measurable response to humidity.

Tu6.32 17:30–19:00 ***Detection of waves and sea-surface vessels via time domain only analysis of underwater DAS data***

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A 100-meter-long fiber optic cable was installed at the bottom of a water tank that is 95 meters long together with a hydrophone for reference. The tank also employs a 6-paddle wavemaker which can generate programmable waves. A model boat was automatically dragged on the surface of the tank via an electrical towing mechanism. The movement of the model boat along the underwater fiber cable and over the hydrophone was recorded using a commercially available NEC Distributed Acoustic Sensing (DAS) system and the hydrophone simultaneously. The experiments were repeated with and without the artificially generated surface waves. The results show the compatibility between the DAS data and the hydrophone data. More importantly, our results show that it is possible to measure the surface waves and to detect a surface vessel approaching the fiber by using only the time domain analysis in terms of detected total energy over time.

Tu6.33 17:30–19:00 ***Hollow-core fiber Fabry-Pérot photothermal gas sensing characteristics over the temperature range of 256–354 K***

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We study the temperature dependance of photothermal signal in a hollow-core fiber (HCF) Fabry-Perot photothermal gas sensor. The photothermal signal generally increases with decreasing temperature, due to the temperature dependent absorption and thermal properties of the gas sample in the hollow-core. The temperature variation also changes the cavity length of the Fabry-Perot, which results in pump power fluctuation in the cavity due to multi-path interference and hence the photothermal signal. This fluctuation can be reduced considerably by applying proper modulation to the pump wavelength. With an 11-cm-long HCF gas cell, we demonstrated a detection limit of ~ 6 ppb acetylene in nitrogen with a 1 s lock-in time constant. With a simple temperature compensation scheme, the photothermal signal fluctuation can be reduced from 48% to 2% over the temperature range of 256–354 K.

Tu6.34 17:30–19:00 ***Deployment of fibre segment interferometry in a high temperature superconducting magnet***

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Measurements from optical fibre interferometers incorporated within a superconducting magnet coil, recorded during energization, are presented. The interferometers were formed between low reflectivity (0.01%), broad bandwidth (10 nm) in-fibre reflectors and were interrogated using the principles of range resolved interferometry, where the retuned signals from the interferometers addressed by a sinusoidally modulated DFB laser diode were demodulated using a quadrature processing technique. The demonstrated low noise (0.3 nε/√Hz), high resolution measurement capability indicates the significant potential for fibre segment interferometry for multiplexed strain measurement in cryogenic systems.

Tu6.35 17:30–19:00 ***Raman-assisted large chirped-pulse Phi-OTDR for long range millikelvin distributed fiber thermometry***

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Chirped-pulse phase-sensitive optical time domain reflectometry (CP-ΦOTDR) has become of standard use in a number of distributed fiber sensing applications, with particularly promising results in long-term highly sensitive measurements. However, the use of large chirps so far has been largely avoided due to the cost/complexity increase, with the majority of academically and commercially studies operating in the ≈1GHz regime. In this paper Large Chirped-Pulse ΦOTDR (LCP-ΦOTDR) employing large chirps (8GHz) and assisted by optimized distributed Raman amplification was used to extend traditional DAS bandwidth to day long high-sensitivity temperature measurements in the order of mK over 50 km of fiber.

Tu6.36 17:30–19:00 ***Large chirped-pulse Phi-OTDR for single-shot to daylong nanostrain measurements with high dynamic range***

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Chirped pulse phase sensitive optical domain reflectometry (CP-ΦOTDR) provides a simple but efficient direct-detection alternative to traditional phase-measuring DAS, with fundamentally different trade-offs and limitations. While the technique has been extensively used both academically and commercially in the ≈1GHz regime, so far, the use of large chirps has been largely avoided due to the cost/complexity increase. In this work, the performance limits of CP-ΦOTDR are investigated when operating with large optical chirps (8GHz). Preliminary results display a supra-linear increase of the dynamic strain range with the optical chirp content, as well as disruptive increase of the long-term performance, with a dramatic decrease of instrumental 1/f noise which is essentially eliminated down to mHz, whilst measuring perturbations equivalent to 100's of MHz of frequency shift. Single-shot strain variations of ±3με at 1kHz trigger, <100 pe/√Hz ASD noise floor and an estimated instrumental nanostrain uncertainty over hour-long measurements were readily obtained.

Tu6.37 17:30–19:00 ***Reference matrix self-correction for perturbation compensation in MFDD-DAS***

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MFDD combined with CP-φ-OTDR has been recently presented as a method for DAS systems that can reduce 1/f noise when compared to traditional φ-OTDR, achieving long-term stability, and enabling precise monitoring of perturbations over extended periods. However, so far, a requirement for the fiber to be unperturbed during fiber calibration stage (i.e., MFDD reference matrix acquisition) limited its application in real-world scenarios, since perturbations occurring at this stage would lead to distortions in posterior measurements. In this paper a self-correction novel method of the MFDD reference matrix is proposed. This concept is experimentally validated. An MFDD-CP-φ-OTDR measurement was conducted in two fiber setups: one with large perturbations during calibration (corrected in post-processing) and another without perturbations during calibration. The method can ensure accurate reference matrices even under strong environmental noise, which enhances the reliability of MFDD-CP-φ-OTDR systems in practical field conditions.

Tu6.38 17:30–19:00 ***A closed loop fiber-optic gyroscope based on phase-locked loop***

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Fiber-optic gyroscopes are widespread sensors used in different fields, such as inertial navigation, seismology and positioning systems. In particular, for applications where high stability and dynamic range are necessary, FOGs are used in closed loop configuration. Here we show an all-electronic closed loop FOG based on a stand-alone phase-locked loop (PLL) system. This approach, is applied directly at the signal processing level without changing the existing optical setup. The PLL stabilizes the signal's frequency reference and suppresses low-frequency fluctuations. A thorough analysis provides a characterization of the gyroscope's performance which shows that this PLL-based technique remarkably reduce the residual noise at low frequency as well as improve the global stability of the system. The gyroscope shows a closed-loop residual noise in the range of 8×10^{-6}–2×10^{-9} rad/s/√Hz over the frequency bandwidth 1mHz – 100 Hz. Future upgrades and perspectives are discussed.

Tu6.39 17:30–19:00 ***Bending-Loss compensated backscattering-enhanced fiber for distributed acoustic sensing***

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The distributed acoustic sensing (DAS) system can reach high sensitivity by wrapping the sensing fiber on an elastomer, however, the bending loss of sensing fiber limits the sensing range of DAS system. To solve this problem, we propose and fabricate a bending-loss compensated backscattering-enhanced fiber (BEF) for DAS based on continuous inscription of ultraweak fiber Bragg gratings and gradually increasing the backscattering along the G.657.A2 bend insensitive fiber (BIF). The SNR of DAS with bending-loss compensated BEF is 5dB higher than that with BIF, at a bending radius of 7.5 mm and bending turns of 200. The bending-loss compensated BEF can also extend the sensing range of DAS greatly under higher bending loss, which could release the contradiction between sensing distance and sensitivity of DAS.

Tu6.40 17:30–19:00 ***High accuracy OFDR-type dynamic distributed strain measurement using phase integration coherence compensation method and interferometer base point shift***

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We developed a novel OFDR system with a new coherence compensation method. This method termed "Phase Integration Coherence Compensation," uses a conventional interferometer to compensate for coherence degradation at any location on the fiber under test by calculating a reference interferometer signal of any delay fiber length. In addition, by dividing the measurement range in the distance direction and performing optimal coherence compensation for each divided region, high Rayleigh scattering spectral correlations are maintained over a wide range of the fiber under test. We achieved dynamic distributed strain measurements over 400 m with a spatial resolution of 50 mm and a strain resolution of 1.3 με. The strain distribution was measured in real time at a rate of 10 Hz, with a measurement error of 0.8 %. Moreover, we simultaneously demonstrated telemetry measurements by shifting the interference base point 130 m.

Tu6.41 17:30–19:00 ***497-km distributed acoustic sensing with 20-m spatial resolution 45-pε/√Hz strain resolution and broad-bandwidth***

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Distributed acoustic sensing (DAS) along 497 km fiber link with relay amplifiers of bidirectional erbium-doped fiber amplifier (EDFA) is reported. By utilization of optical pulse compression distributed acoustic sensing (OPC-DAS) system and proposed multi-mode multiplexing scheme, the sinusoidal vibration oscillating at 240 Hz at the far end of 497 km fiber link is successfully restored with a spatial resolution of 20 m and a strain resolution of 45 pε/√Hz. To the best of our knowledge, this is the longest distance reported to date for a DAS system using EDFA as the relay module, while maintaining such high spatial resolution, high strain resolution, and wide frequency response range (FFR).

Tu6.42 17:30–19:00 ***Field trial of DAS data analysis methods for detecting excavation encroachment***

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Underground optical cables for telecommunication services are at constant risk of damage from excavation encroachment, so methods to detect excavations around optical cables are urgently needed. In this paper, we propose two algorithms for detecting excavation vibration from distributed acoustic sensing (DAS) data collected from deployed fiber cables. Even though the vibration features differ greatly with the excavation machine and environmental vibration degrades accuracy in general, proposed algorithms achieved highly accurate excavation detection.

Tu6.43 17:30–19:00 ***Self-supervised pre-training for distributed acoustic sensing data feature learning with Transformers***

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Distributed acoustic sensing (DAS) is a vibration measurement technology, achieving high spatial resolution while maintaining cost-effectiveness and robustness in harsh environments. The sensing data, i.e., waterfall plots, are two-dimensional (2D) spatial-temporal, which is abstract for humans to analyze. Consequently, it is essential to present data with more understandable features for various

DAS applications. This paper introduces a new Transformer model and extends the self-supervised masked autoencoder to learn the features of waterfall plots, referred to as DAS-MAE. The DAS-MAE can understand the semantic meaning of waterfall plots without human intervention or data labels. After pre-training on the open dataset obtained in the lab, DAS-MAE demonstrates high capability and generalization in practical applications.

Tu6.44 17:30–19:00 ***Exploring the use of a virtual reference spectrum in the Vernier effect***

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The optical Vernier effect (OVE) enhances optical fiber sensor sensitivity by combining two interferometers. This study uses a single open-cavity Fabry-Perot interferometer (FPI) with a large lateral offset and a virtual reference spectrum for OVE. FPIs of varying lengths (118–539 µm) were tested with glucose solutions to monitor refractive index changes. A sensor with Lsens = 292 µm was selected, and virtual reference spectra (Lref= 320–390 µm) were generated using the OriginPro software. Spectral overlap analysis achieved sensitivity of (20562 ± 1461) nm/RIU and a magnification factor of M = 14.1. This approach eliminates FPI length requirements, reduces costs, and simplifies signal processing.

Tu6.45 17:30–19:00 ***A new perspective on the optical Vernier effect and Its apparent sensitivity enhancement***

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This work analyzes the sensitivity of an optical system consisting of two fiber Fabry-Pérot (FP) interferometers and the apparent increase in sensitivity due to the harmonics of the Vernier effect. Two scenarios are examined: (1) when the larger FP cavity acts as the sensor, and (2) when the smaller FP cavity acts as the sensor. The computation analysis reveals that in the first scenario, higher-order spectral harmonics yield greater sensitivity for maxima and minima of the same order. In the second scenario, however, the sensitivity remains constant and does not depend on the harmonic order. Moreover, it is demonstrated that the sensitivity curve is identical for both scenarios, regardless of the harmonic order. This outcome occurs because the use of spectral harmonics simply reduces the free-spectral range in certain situations, bringing the extrema closer to the maximum sensitivity condition (i.e., ΔL = 0) and thereby increasing sensitivity. Consequently, if points on the envelope other than maxima or minima are used, the sensitivity achieved is the same for both scenarios.

Tu6.46 17:30–19:00 ***Quasi-distributed ultrasonic sensing scheme based on crosstalk suppressed optical coherence domain reflectometry***

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A quasi-distributed acoustic sensing scheme based on optical coherence domain reflectometry (OCDR) is proposed, which significantly reduces the system's demand for receiver bandwidth. The measurement of 1 MHz ultrasonic signals at centimeter reflectors interval is achieved in the experiment. This scheme is expected to be employed in ultrasonic flaw detection and other fields to realize array ultrasonic sensing.

Tu6.47 17:30–19:00 ***Frequency and time multiplexed high-precision BOTDR using a frequency-shifting loop***

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The Brillouin optical time domain reflectometer has become a widely applied distributed sensing technique thanks to its unique advantages such as single-end access, simple system architecture and ease of implementation. However, with the development of BOTDR, its limitations, such as low system signal-to-noise ratio and limited maximum sensing distance, have become increasingly apparent. Traditional methods commonly adopt large number of averages to improve system accuracy, which leads to extended measurement time. In response to the above issues, we propose a high accuracy BOTDR based on a frequency-shifting loop. This technology employs frequency division multiplexing, which not only maintains spatial resolution but also enhances the system's measurement accuracy by a factor of √N using N frequencies. Additionally, it maximizes the Local Oscillator power, thereby breaking the limitations imposed by PD saturation. This method provides a new approach for multi-frequency BOTDR and contributes to the development of high-precision and long-distance sensing techniques.

Tu6.48 17:30–19:00 ***An 80 km open path Brillouin optical time domain analysis with far-end probe light***

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The sensing fiber in Brillouin optical time-domain analysis (BOTDA) is usually in a two-end accessed, close path form, which may be only half utilized in application. In this work, we propose a long-range open path BOTDA with far-end probe light. The sensing fiber is two-end accessed, open path, and the probe wave is provided by a remote dedicated light source via the far-end of fiber. Injection locking is employed in the pump light side to synchronize the laser frequency of both sides. 127-bit Simplex encoding (with 80 averaging) is also introduced to enhance the performance. In the demonstration experiment, the BOTDA achieves 0.79 MHz frequency resolution and 5.0 m spatial resolution at the far-end of 80 km fiber in open path.

Tu6.49 17:30–19:00 ***Ultrahigh-resolution compact spectropolarimeter based on leaky-mode speckle from random interference and scattering***

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An ultrahigh-resolution computational spectropolarimeter is demonstrated using a microsphere fiber resonator and tapered coreless fibers, achieving a 0.1-pm spectral resolution, a 100-nm operating bandwidth and a polarization measurement error of 5.81 × 10-6 in a compact volume.

Tu6.50 17:30–19:00 ***Fiber-optic DAS for efficient wellbore data transmission***

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A significant number of downhole sensors monitor well conditions, but data transmission faces speed and reliability challenges. Mud pulse telemetry (MPT) is used during drilling but has low data rates, while electromagnetic or acoustic waves in production are hindered by signal issues. We employ fiber-optic distributed acoustic sensing (DAS) for wellbore data communication, using a DAS spatial

correlation selection technique (DSCT) to mitigate Rayleigh signal fading. This achieves a 1000 bps data rate with a bit error rate (BER) of 8.33×10^(-5) over 1 km. We demonstrated this system in a lab and designed it for downhole use in production tubing, which would significantly enhance the reliability and efficiency of real-time well monitoring.

Tu6.51 17:30–19:00 ***Fiber-artefact methodology for distributed Brillouin sensing***

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We demonstrate a metrological fiber-optical artefact for distributed Brillouin sensing, and develop methodology for traceable distance calibration, and tests for distance-related measurement biases for the sensing measurand and the spatial resolution. The fiber artefact has been developed in the framework of the European Partnership in Metrology, in the ongoing INFOTherm project, which focuses on establishing metrological methods and European infrastructure within the field of optical fiber sensing.

Tu6.52 17:30–19:00 ***High Performance Φ-OTDR with the temporally sequenced multi-frequency multi-wavelength chirped source***

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A novel phase-sensitive optical time-domain reflectometry (Φ-OTDR) based on the temporally sequenced multi-frequency multi-wavelength chirped source is proposed, with 50kHz detection bandwidth and -52.5dB rad2/Hz mean noise floor. The scheme can simultaneously meet the requirements of high-bandwidth and high signal-to-noise ratio (SNR) in the fields of large-scale structural health inspection and oil and gas pipelines.

Tu6.53 17:30–19:00 ***High-speed strain measurement in dual-laser Brillouin optical correlation-domain reflectometry***

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We experimentally demonstrate the operation of a newly developed high-speed dual-laser Brillouin optical correlation-domain reflectometry (BOCDR) by conducting real-time distributed strain measurement of 100 sample points along a 3.5-m-long FUT. The unique operation of the proposed configuration offers several advantages, including reduced reliance on high-specification electrical spectrum analyzers, large strain dynamic range and constant spatial resolution during the distributed measurement.

Tu6.54 17:30–19:00 ***Fiber optic Fabry-Pérot sensor multiplexing technology Based on self-calibration wavelength modulation***

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A self-calibrating wavelength modulation multiplexing technique is proposed to achieve simultaneous demodulation of Fabry–Pérot sensors with different cavity lengths. Real time calibration of laser wavelength to maintain robustness of the multiplexing system in applications involving large environmental perturbations.

Tu6.55 17:30–19:00 ***Monitoring of FTTH-PON using direct-detection FBG-assisted Φ-OTDR***

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A fiber Bragg grating-assisted phase-optical time domain reflectometer (FBG-assisted Φ-OTDR) was developed to interrogate an FTTH network installed over a total distance of 25 km. The network includes a 1x4 splitter at the FAT (Fiber Access Terminal). The sensor interrogates each branch of the aerial section with a probe signal consisting of a double-pulse. In the final meters of each branch, a pair of weakly reflective FBGs was placed and the corresponding interference signal was used to identify a possible cable motion. A mitigation method for polarization fading inherent to FBG-assisted Φ-OTDR is also described. The proposed approach allows locating a cable motion at the end of the tree-like structure of the FTTH network, which corresponds to the aerial part of the network. Detection and localization of cable motions enable the repair of a fault before it gives rise to a cable deterioration and a detrimental insertion loss.

Tu6.56 17:30–19:00 ***Extending the range of measurement and the sensitivity response of Fabry-Perot interferometric sensors***

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Two-wave interference fiber interferometers have a higher sensitivity response when they have longer optical path difference, which in exchange produce a short interference period; and this period ultimately limits the range of measurement due to the 2π phase ambiguity. In this work, a novel methodology is proposed to increase both the measurement range of an interferometric fiber sensor and its sensitivity response. In a first stage, for proof of concept, the measurement range is increased 15 times, which translates to an increase of measurement range from 23°C to 360°C. Furthermore, in a second stage, the Vernier effect is used to increase the sensitivity response by means of a virtual cavity used as a reference cavity. Here, the sensitivity response was increased by a factor of 15. This two-stage methodology is described by modeling and simulation, and demonstrated with experimental results. The importance of the methodology lies in the optimization of the performance of interferometric fiber sensors.

Tu6.57 17:30–19:00 ***Soft force sensor based on silicone rubber embedding single mode fiber using Brillouin optical correlation-domain reflectometry***

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We propose a distributed optical fiber sensor embedded in a silicone rubber block for potential application to soft robots. The system uses Brillouin Optical Correlation-Domain Reflectometry (BOCDR) to measure the strain distribution along a single fiber embedded randomly in three dimensions. Compression experiments were conducted in both the x and y directions, revealing distinct strain patterns for each orientation. The results confirm the feasibility of capturing multi-axial deformation using a single fiber, and the silicone block demonstrated reversible deformation with minimal hysteresis. This approach provides a promising sensing platform for soft robotic structures requiring flexible and distributed strain measurements.

Tu6.58 17:30–19:00 ***Distributed fibre-optic acoustic sensing: a tool to assess rock properties during active and passive seismic surveys***

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Ubiquitously used for monitoring pipelines and infrastructures, distributed fibre-optic acoustic sensing is becoming an emerging technology for earthquake monitoring thanks to the possibility to interrogate a large vast of distances with a dense number of sensing points in which an optical fiber cable can be retrofitted. Moreover, it can also be used as a tool by geophysicists for the characterization of subsurface elements, such as rocks, faults, and geological structures before excavation work. In this work, we present two applications where DAS technology can contribute to assess rock properties during passive (in a mining site) and active (in a lake) seismic surveys. In both cases, seismograms generated from DAS measurements were comparable to those measured by traditional receivers, paving the way towards their use for assessing rock quality during surveys.

Tu6.59 17:30–19:00 ***Self-referenced carrier frequency offset interferogram correction for dual-comb systems***

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Dual optical frequency comb (DOFC) has been unveiled as a prevailing tool for an increasing range of applications, such as molecular spectroscopy, ranging, imaging, and distributed sensing. Maintaining a high degree of temporal stability between the two mutually coherent interfering combs composing the DOFC is essential in emerging applications such as ranging and distributed sensing, where the amplitude and/or the phase profiles of subsequent interferograms are compared to extract time-varying information. In this work, we present a simple and efficient self-referencing correcting technique aimed at estimating and compensating for carrier frequency offset of time-domain interferograms. We validate our algorithm through a proof-of-concept spectroscopy experiment based on DOFC generated using optically injected gain-switched semiconductor lasers. Our experiments validate proper interferogram alignment with an SNR improvement of 38 dB along an interrogation time of nearly 0.2 s.

Tu6.60 17:30–19:00 ***Potential of electrical-domain interference driven by modal distribution in optical fibers for strain and displacement sensing***

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This paper reports the sensing potential of an interference-like spectral response in the electrical domain, observed when sub-cutoff-wavelength light passes through certain fiber arrangements, like a plastic optical fiber (POF) or an air gap between silica single-mode fibers. Monitoring the photo-detected signal on an electrical spectrum analyzer reveals that interference dips move when external environmental conditions change. Measuring the frequency of the first spectral dip, results show that applying strain to the POF shifts the dip frequency, suggesting potential for strain sensing. On the other hand, adjusting the air gap between silica fibers also shifts the spectral dip, enabling displacement sensing. Our experimental study reveals that these behaviors cannot be described by standard Mach-Zehnder or typical multimodal interference, and is presumably driven by the modal distribution and the resulting measured power in the electrical domain. While the mechanism remains under study, the fast operation capability and low-cost nature of the method suggest that it can be effectively exploited for strain and displacement detection.

Tu6.61 17:30–19:00 ***Distributed temperature measurement with Brillouin optical correlation-domain reflectometry at 8.5 mm spatial resolution***

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We explore Brillouin optical correlation-domain reflectometry (BOCDR) at modulation frequencies near the theoretical limit defined by the Brillouin bandwidth – about 30 MHz for silica single-mode fibers. By measuring the Brillouin gain spectrum (BGS) in this frequency range, we find that above ~25 MHz, a periodic wave originating from the modulation frequency starts to overlay the BGS, posing a challenge for quantitative distributed measurements. Consequently, the upper limit of viable modulation frequencies depends not on the Brillouin bandwidth itself but on the range in which no periodic waves are superimposed on the BGS. Using this new insight, we set a modulation frequency limit at around 20 MHz, enabling an 8.5 mm spatial resolution – the world's highest reported in BOCDR-based distributed measurement – to detect temperature changes in a 9 mm-long heated section of a silica single-mode fiber.

Tu6.62 17:30–19:00 ***Proposal of OCDR based on periodic pseudo-random modulation***

Yuta Higa*[a], Keisuke Motoda[a], Soshi Yoshida[a], Takaki Kiyozumi[b], Takahiro Ishimaru[c], Hiroshi Takahashi[c], Kunihiro Toge[c], Yosuke Mizuno[a]; [a]Faculty of Engineering, Yokohama National University, 79-5 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan; [b]Graduate School of Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan; [c]NTT Access Network Service Systems Laboratories, 1-7-1 Hanabatake, Tsukuba, Ibaraki 305-0805, Japan

We propose and experimentally demonstrate an optical correlation-domain reflectometry (OCDR) method based on periodic pseudo-random modulation (PPRM). In conventional OCDR systems that employ sinusoidal modulation, additional "noise peaks" sometimes appear before and after the true reflection peak. Here, we show that PPRM effectively suppresses these unwanted noise peaks. Moreover, without introducing extra hardware, we achieve a measurement range of 3 km and a spatial resolution of around 5 cm – a performance level previously unattainable under standard OCDR conditions.

Tu6.63 17:30–19:00 ***Proposal of correlation-dip-based optical correlation-domain reflectometry***

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Conventional distributed measurement methods that employ correlation-domain techniques typically use a "correlation peak" as the measurement point. In this work, we propose and experimentally demonstrate a novel form of optical correlation-domain reflectometry that targets the "correlation dip," located between two correlation peaks. As the reflected spectrum observed at the correlation dip exhibits its maximum bandwidth, we can selectively detect the reflection from the fiber under test by measuring the power in that broad frequency band. We verify the basic operation of this technique experimentally.

Tu6.64 17:30–19:00 ***Interferometric optical fiber sensor with a polyoxometalate-doped xerogel for the selective detection of ammonia***

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This study presents the development and evaluation of an interferometric optical fiber sensor (I-OFS) based on a Single Mode Fiber-No Core Fiber-Single Mode Fiber (SMF-NCF-SMF) structure and functionalized with a silica xerogel doped with a titanium (IV)-containing polyoxomolibdate (GeMoTi). The behavior of the sensor was tested under saturated atmospheres of ammonia, water, and various volatile organic compounds (VOCs), including ethanol, acetone, and toluene. The response is characterized in terms of wavelength shifts, which are highlightable for ammonia due to its strong chemical interactions with the doped xerogel. The response and recovery times were evaluated for each analyte, pointing out ammonia as the compound with the fastest and most stable detection performance. These results reinforce the hypothesis of using GeMoTi-doped xerogels to enhance the selectivity of I-OFS for the detection of closely related amines.

Tu6.65 17:30–19:00 ***Time-transformed spectral analysis for multiparametric sensing using a single antiresonant interferometer***

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This work explores the potential of spectral composition analysis in the time-transformed domain for multiparametric sensing using a single in-line hollow-core interferometer. By effectively distinguishing between antiresonance guidance and Fabry Perot-induced contributions, this approach allows simultaneous measurement of two independent parameters. The sensor, featuring polyimide coating, was characterized during humidity cycles at varying temperatures by monitoring phase variations in the transformed domain. The distinct sensitivities of antiresonance and Fabry-Perot components allowed the determination of temperature and relative humidity using a multiparametric linear model, achieving good agreement with experimental results and underscoring its robustness for multiparametric sensing applications.

Tu6.66 17:30–19:00 ***Long range Brillouin optical time-domain analysis using cyclic m-sequence***

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For Brillouin optical time domain analysis (BOTDA), the state-of-the-art encoding schemes are usually developed based on the Golay code, the simplex matrix, and the cyclic (simplex) pulse coding. In this work, we propose a convenient BOTDA encoding scheme employing the pseudo-random binary sequence (PRBS).The pump laser is constructed based on the m-sequence with unipolar, return-to-zero (RZ) code chips.Correspondingly, a correlation function with bipolar, one-hot code chips is introduced to realize a fast demodulation.In the demonstration experiment, a 10-th order m-sequence (length is 1023) is used in the PRBS BOTDA, achieving 0.64 MHz BFS resolution and 4.4 m spatial resolution near the 50.4 km fiber far-end, within 40 s measurement time (0.4 s averaging $\times$ 100 scanning frequencies).

Tu6.67 17:30–19:00 ***Frequency-division-multiplexed optical correlation-domain reflectometry for overcoming sampling rate constraint***

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This paper applies frequency-division multiplexing (FDM) to optical correlation-domain reflectometry (OCDR) to mitigate the spatial resolution constraints imposed by the sampling rate of an analog-to-digital converter. As a result, it becomes possible to measure the reflection distribution of the entire fiber under test (FUT) in real time, while simultaneously achieving high-precision local measurements. Using the FDM–OCDR system, we successfully obtain the reflection distribution over a 500 m FUT within 10 ms, along with a spatial resolution of ~16 cm in localized regions.

Tu6.68 17:30–19:00 ***Beat spectrum in dual-laser optical correlation-domain reflectometry***

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Dual-laser Brillouin optical correlation-domain reflectometry down-converts Brillouin signals to lower frequencies, eliminating the need for lengthy delay lines. In this work, we derive a theoretical formula for the dual-laser beat spectrum, which governs spatial resolution, and verify its validity through experiments.

Tu6.69 17:30–19:00 ***Dual sideband probe Pound-Drever-Hall Brillouin optical time domain analysis***

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The distributed Pound-Drever-Hall Brillouin optical time domain analysis scheme based on dual-sideband probe configuration is proposed, offering a flat compensation for the pump wave. The sensing distance is effectively extended up to 75 km with the spatial resolution of 5 m, achieving the frequency resolution of 0.84 MHz. Besides, the benefit of fast measurement persists, with 3.3 seconds per interrogation after 3000 times averaged.

Tu6.70 17:30–19:00 ***Experimental investigation of relationship between modulation frequency and spatial resolution in OCDR with frequency shifter***

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We experimentally investigate how the modulation frequency affects the spatial resolution in optical correlation-domain reflectometry (OCDR) with a frequency shifter, a parameter conventionally believed to have no influence. By measuring an open end in a fiber under test at various modulation frequencies and analyzing the reflection peak, we observe that spatial resolution improves at higher modulation frequencies. These results reveal a trade-off between measurement range and resolution in OCDR systems with a frequency shifter. In addition, beat spectrum analysis explores the underlying cause of this behavior.

Tu6.71 17:30–19:00 ***Vernier effect-based C-shaped fiber sensor for temperature measurement***

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In this paper, we propose a Vernier effect-based fiber-optic temperature sensor. The structure of the sensor is fabricated by cascading a single mode fiber (SMF) pigtail together with a C-shaped fiber segment and another SMF segment. In this original sensing architecture, the C-shaped fiber segment constitutes a Fabry-Perot interferometer (FPI) used as a sensing cavity while the SMF segment serves as a reference cavity. These two cavities have a slightly different optical path length to trigger the Vernier effect. Both theoretical calculations and experiments are carried out in the characterization of the sensor measuring temperature. The experimental sensitivity of the sensor is found to be -9.15 nm/°C for temperature measurement.

Tu6.72 17:30–19:00 ***Strain and temperature simultaneous measurement in kilometer-scale fiber-optic gyroscopic coils using OFDR***

Fan Zhang[a], Xiang Zhang*[b,c,d], Cuofu Lin[b,c,d], Jun Yang[b,c,d], Yuncai Wang[b,c,d], Yuwen Qin[b,c,d]; [a]School of Physics and Optoelectronic Engineering, Harbin Engineering University, Harbin, China; [b]Key Laboratory of Photonic Technology for Integrated Sensing and Communication, Ministry of Education of China, Guangdong University of Technology, Guangzhou, 51006, China; [c]Guangdong Provincial Key Laboratory of Information Photonics Technology, Guangdong University of Technology, Guangzhou, 51006, China; [d]Institute of Advanced Photonics Technology, School of Information Engineering, Guangdong University of Technology, Guangzhou, 51006, China. *qyy@hrbeu.edu.cn

In this paper, a delay correction method is proposed to overcome the Rayleigh backscattering (RBS) spectra mismatch between orthogonal polarization axes caused by birefringence delay, thus extending measurement distance. In the experiment, the strain and temperature simultaneous measurement of the 3 km fiber-optic gyroscopic coil is realized at a spatial resolution of 5 cm. This research provides a crucial basis for the performance evaluation of fiber-optic gyroscopes.

Tu6.73 17:30–19:00 ***Fiber-optic micro-displacement sensor probe based on Vernier effect***

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In this paper, we propose an intrinsic fiber-optic displacement probe in which two cascaded Fabry-Perot (F-P) cavities are directly printed on the fiber tip using the two-photon polymerization lithography technique. This probe operates based on the so-called Vernier effect. Thus, shifts of the periodic spectral envelops are interrogated in response to the micro-displacements of the fiber probe. Experimentally, the sensitivity of the sensor probe was characterized as 24.6 nm/μm, that is comparable to the highest sensitivity of the previous counterparts. Compared to the extrinsic F-P fiber sensors, the proposed fiber probe could be directly placed in contact with micro-objects of interest to measure the corresponding displacements, which is significantly favorable for its practical applications. Advantages of the proposed sensor include ease of operation, high sensitivity, great flexibility, and small footprint.

Tu6.74 17:30–19:00 ***An optimized method to suppress the spontaneous MI induced phase noise in the interferometric fiber sensing system***

Dongying Wang[a], Xiaoyang Hu*[a], Jianfei Wang[a], Mo Chen[a], Yang Lu[a], Wei Chen[a], Hantao Li[a], Zhou Meng*[a,a]College of Meteorology and Oceanology, National University of Defense Technology, Changsha 410073, China. *huxiaoyang08@sina.cn; *zhoumeng6806@139.com

In the interferometric fiber sensing system, the spontaneous modulation instability (MI) initiating from the amplified spontaneous emission (ASE) noise is a main limitation factor of the maximum input power. The spontaneous MI leads to the serious phase noise, which degrades the system performance. Here, we propose an optimized method to suppress the spontaneous MI by controlling the phase difference. Frist, we impose weak coherent sidebands, which can suppress the spontaneous MI by exciting the induced MI. Subsequently, we carefully control the phase difference between weak coherent sidebands and pump. The results show that the phase noise can be suppressed by controlling the phase difference. Compared to the system without phase difference control, the phase noise is reduced by -3 dB (re 1 rad/√Hz).

Tu6.75 17:30–19:00 ***Implementation of externally modulated Brillouin optical correlationdomain reflectometry using single-sideband modulator***

Ryuki Ohata*[a], Kouta Ozaki[a], Keita Kikuchi[b], Heeyoung Lee[b], and Yosuke Mizuno[a,c]; [a]Faculty of Engineering, Yokohama National University, 79-5 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan; [b]Graduate School of Engineering and Science, Shibaura Institute of Technology, 3-7-5 Toyosu, Koto-ku, Tokyo 135-8548, Japan; [c]Institute of Multidisciplinary Sciences, Yokohama National University, 79-5 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan.

Brillouin optical correlation-domain reflectometry (BOCDR) enables distributed strain and temperature measurements along optical fibers with relatively high spatial resolution and random-access capability. Conventional BOCDR systems require sinusoidal frequency modulation of the laser, implemented either by direct or external modulation. When external modulation is employed, double-sideband modulators are often used. However, because a bandpass filter must select only one of the two sidebands, the resulting signal-to-noise ratio tends to be low. Here, we propose and experimentally verify an external-modulation BOCDR scheme that uses a single-sideband modulator instead. By eliminating the need to discard one sideband, this approach improves energy efficiency.

Tu6.76 17:30–19:00 ***Analysis on the strain and temperature dependence of stimulated Brillouin scattering in a PANDA-type few-mode fiber***

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Few-mode fibers (FMFs) have potential to overcome the limitations of single-mode fibers (SMFs) in sensing applications, enabling multi-parameter measurement capabilities. PANDA-type FMFs, with polarization-maintaining and higher-order mode support, are particularly well-suited for distributed strain and temperature sensing. This study involves the experimental investigation of intra- and intermodal Brillouin gain spectra (BGS) in PANDA-FMFs, with a focus on their strain and temperature dependencies. Brillouin optical correlation-domain analysis (BOCDA), enhanced by low-frequency differential measurement and far-field detection, effectively suppresses modal interferences and enables peak-by-peak investigation of multipeak BGS. Experimental results show that the strain dependence ranges from 0.0448 to 0.0456 MHz/ε, and the temperature dependence spans 0.998 to 1.106 MHz/°C.

Tu6.77 17:30–19:00 ***Water absorption effects on distributed temperature sensing using polyimide-coated optical fiber***

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Polyimide-coated fibers are becoming more popular for distributed temperature sensing (DTS) because this coating can withstand much higher temperatures than the standard acrylate coating. As a hygroscopic material, polyimide can absorb water from the air, changing its properties, which may result in a modified temperature response of the sensing fiber. This study investigates the effect of water absorption on the performance of polyimide-coated optical fibers with different sizes and properties. The thermal response of these fibers was determined experimentally from 20°C to 90°C at a broad relative humidity level ranging from 10% to 90%. The results show that all the fibers experienced a decrease in temperature sensitivity as humidity increased, with the most noticeable non-linear spectral shift observed at higher humidity levels. These findings highlight the importance of optimizing fiber design and coating properties to balance stability and sensitivity, ensuring the reliable performance of DTS systems under extreme environmental conditions.

Tu6.78 17:30–19:00 ***A stimulated Brillouin scattering suppression method in the remote interferometric fiber sensing system based on electro-optic phase modulator and modified phase-generated carrier***

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We propose and demonstrate a stimulated Brillouin scattering (SBS) suppression method in the remote interferometric fiber sensing systems based on electro-optic phase modulator and modified phase-generated carrier (PGC) demodulation method. The phase of the laser source is modulated using an electro-optic phase modulator, which suppresses SBS and generates the high-frequency carrier signal for PGC demodulation, simultaneously. The results indicate that the maximum input power of the system can be increased effectively. This work provides a simple method for suppressing SBS in the remote interferometric fiber sensing systems.

Tu6.79 17:30–19:00 ***Improving the strain measurement accuracy in OFDR by suppressing residual phase noise***

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This paper proposes an optimal matching method between the auxiliary interferometer delay fiber and the device under test, aimed at improving strain measurement accuracy in optical frequency-domain reflectometry (OFDR) by minimizing residual phase noise (RPN). The method achieves a spatial resolution of 2 mm and strain measurement accuracy better than 1.5 $\mu\varepsilon$ (2σ) within the optimal matching range of a hundred-meter test fiber.

Tu6.80 17:30–19:00 ***Positive and negative slope assisted BOTDA based on five-frequency light to compensate for the effect of loss and reflection***

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Slope assisted Brillouin optical time domain analysis (SA-BOTDA) with a linear slope was realized by using five-frequency pump and probe lights, where the sign of the slope was changed by controlling the optical power of each frequency component for the multi-frequency pump and probe. By employing both negative and positive linear slopes in the SA-BOTDA, we compensated for the effects of optical loss and Fresnel reflection at a mechanical connector.

Tu6.81 17:30–19:00 ***Slope-assisted BOTDA using Brillouin gain and loss spectra with phase-shift pulse pump for improved spatial resolution and reduced measurement time***

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In this paper, we deploy phase-shift pulse (PSP) method in a slope-assisted Brillouin optical time domain analysis (SA-BOTDA) along with both Brillouin gain spectrum (BGS) and Brillouin loss spectrum (BLS) measurements for simultaneously improving the spatial resolution and the measurement time. It is experimentally confirmed that the measured optical signal power in the proposed PSP-SA-BOTDA linearly changes with Brillouin frequency shift of approximately 70MHz. The result of distributed measurement shows that the spatial resolution has improved to 50 cm.

Tu6.82 17:30–19:00 ***Temporal data densification in fiber optic interferometer with triangular-wave phase modulation for dynamic displacement measurement***

Kano Ito, Kai Asanuma, Yuki Noda, Sora Matsumoto, and Yosuke Tanaka; Graduate School of Engineering, Tokyo University of Agriculture and Technology 2-24-16 Naka-cho, Koganei, Tokyo 184-8588, Japan

We developed a new data processing scheme for temporal data densification in a fiber optic interferometer with triangular-wave phase modulation for dynamic displacement measurement. The proposed method uses all the peak-point data of the interference signals in the time domain, which can enlarge the measurement bandwidth by four times compared with the previous methods. We have validated the principle of the proposed method by measuring the dynamic displacement of PZT vibrations at 80 kHz.

Tu6.83 17:30–19:00 ***Proposal of phase measurement method from FFT on broadband probe based BOTDA***

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We propose a method that realize BPS measurement by simultaneously measuring signal lights and reference lights in broadband probe based BOTDA by setting a delay fiber in the probe's path. We compare the measured FFT phase with BPS shape and confirm the validity of the proposed method. In addition, we change the temperature of the fiber under test and confirm the correspondence between the temperature change and the BFS change.

Tu6.84 17:30–19:00 ***Efficient Inhibition of Rayleigh scattering in interferometric sensor through random phase noise***

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Rayleigh scattering is the main restrictive factor for the long-distance fiber sensing especially in fiber optic interferometric sensor with uplink and downlink transmission shared common leading fiber. Here, the interrogation pulses are modulated by binary phase - shift keying (BPSK) to inhibit the Rayleigh scattering, and the binary sequence is generated from random noise. Experimental results show that with the modulation of noise sequence, the background noise of 10 km sensing system resulted from Rayleigh scattering is inhibited more than 20 dB. This report provides an economical and convenient method to solve the Rayleigh scattering without any devices in sensing end.

Tu6.85 17:30–19:00 ***Fast and robust post-processing algorithm for STFT-BOTDR***

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We propose a post-processing algorithm for estimating the Brillouin frequency shift (BFS) to meet the high-performance demands of Short-Time Fourier Transform-based Brillouin Optical Time Domain Reflectometry (STFT-BOTDR). The methodology integrates few-point STFT, post-interpolation, and fitting window correction techniques, achieving simultaneously a high accuracy, a high precision, and a rapid processing time.

Tu6.86 17:30–19:00 ***High-frequency response TGD-OFDR-based distributed acoustic sensor utilizing frequency-shift loop***

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A DAS system with 1.5 MHz sampling rate over 600 m fiber and 4 pε√Hz sensitivity is developed by introducing a frequency-shift-loop (FSL) to the time-gate digital OFDR system. The FSL produces the probe pulse for frequency division multiplexing with high signal-to-noise ratio. It is composed of a 3dB coupler, an acousto-modulator for frequency shifting and a semiconductor optical amplifier (SOA) for optical power compensation. When a linear frequency chirp pulse is incident to the FSL, 9 probe pulses with different center frequency and equal time interval are generated and sent to the fiber under test for detection. The back reflected lightwave is coherence detected by polarization diversity receiver, and then the demodulated signals by the corresponding matched filters are resorted in time sequence. In the experiment, 496 kHz vibration waveform is recovered with a signal-to-noise ratio over 20 dB, strain resolution of 4 pε√Hz and spatial resolution of 1.5 m.

Tu6.87 17:30–19:00 ***Quasi-static pressure sensitivity of single-mode optical fibers***

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We report on characterizations of standard single mode optical fibers sensitivity to pressure. We used an unbalanced Michelson interferometer, whose long arm is the fiber under test. The fiber is placed inside an airtight chamber, in which water is then added. The pressure is swept at 1 Hz by injecting air into the chamber. The fiber mainly experiences pressure variations, with negligible thermal fluctuations due to water thermal capacitance. The fiber pressure sensitivity is extracted using Bessel decomposition of the interferometer output signal. We characterized standard G.652 single mode fiber fibers with different tubing, and highlighted its impact on the overall sensitivity. We also tested the setup for a fiber embedded into a Plexiglas plate, here again showing the coupling with the structure and the sensitivity dependence to embedding depth.

Tu6.88 17:30–19:00 ***High-sensitivity distributed random lasing sensor***

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We report temperature mapping of a single mode fiber by using a random lasing sensor driven by current pulses in a semiconductor optical amplifier. The backscattered light from the fiber provides random feedback for lasing with temperature sensitive wavelength in a similar way as fiber gratings do. The laser operates in mode locking regime with transform-limited pulses. We address the sensed region by varying the pulse repetition rate while the pulse width defines the resolution of the distributed measurement. We show that a 100 m long-fiber can be easily mapped with temperature and spatial resolutions of 0.01°C and 50cm respectively.

Tu6.89 17:30–19:00 ***A novel distributed interferometer for security monitoring of ultra-long-distance submarine optical cables***

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A novel dual-wavelength unidirectional circular propagation asymmetric Mach-Zehnder interferometer (UCAMZI) is proposed to achieve the security monitoring of ultra-long-distance submarine optical cables. UCAMZI is characterized by the wide dynamic range, ultra-long detection distance, high frequency response and compatibility with existing submarine repeaters. Experimental results show that at a 150 - km sensing distance, the location error is around 56 m, and the response frequency can reach 37 kHz. It holds great potential for monitoring long - distance submarine optical cables.

Tu6.90 17:30–19:00 ***Suppression of Doppler-shift-induced crosstalk in linear-frequency swept Φ-OTDR by using scattering enhanced fiber***

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Linear-frequency-swept (LFS) phase-sensitive optical time domain reflectometry (φ-OTDR) breaks the trade-off between spatial resolution and signal-to-noise ratio. However, the vibration induced Doppler shift of Rayleigh backscattering (RBS) generates serious crosstalk beyond the vibration area. Here, we propose and demonstrate a Doppler-shift-suppression distributed acoustic sensor (DAS) based on LFS φ-OTDR and discrete Rayleigh-enhanced single-mode fiber (eSMF). The relationship between the crosstalk and detection pulses parameters, including pulse width, chirp rate and bandwidth, was investigated. Moreover, a discrete eSMF was used to reduce the phase change rate, and hence could suppress the crosstalk. As a proof of concept, a vibration signal with a frequency of 8 kHz was successfully detected with a spatial resolution of 10 cm, a strain resolution of 110 pε/√Hz and an improved crosstalk suppression of 20 dB. The proposed Doppler-shift-suppression DAS system could potentially be used for ultrasonic structural health monitoring.

Tu6.91 17:30–19:00 ***Frequency distortion suppressed phase-sensitive OFDR by using dual-wavelength digitally enhanced interferometry***

Congfan Wang, Weilin Xie*, Jun Xue, Qiang Yang, Bowen Li, Xiang Zheng, Xin Li, Sijing Yang, Wei Wei and Yi Dong Key; Laboratory of Photonics Information Technology, Ministry of Industry and Information Technology, School of Optics and Photonics, Beijing Institute of Technology, No. 5, Zhongguancun South Street, Haidian District, Beijing 100081, China. *wlxie@bit.edu.cn

We report on a phase-sensitive optical frequency domain reflectometry that allows for frequency distortion suppression in distributed sensing by using dual-wavelength digitally enhanced interferometry.

Preserved sensing performance for a strain precision of 0.1 με/√Hz with a sensing spatial resolution of 1.25 m along 4.6 km has been verified in the presence of both environmental and artificially induced frequency distortions, testifying the effective frequency distortion suppression.

Tu6.92 17:30–19:00 ***Realization of a collinear pump-probe beam configuration for a fiber-optic photothermal trace gas sensing system***

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We present the realization of a collinear pump-probe beam configuration for photothermal interferometry-based trace gas sensing systems using a custom-made, fiber-coupled and dichroic extrinsic Fabry-Perot etalon. The system additionally supports the common crossed-beams, as well as an angled-beams configuration. This allows a direct comparison between the configurations and clearly demonstrates the increasing sensitivity with increasing beam overlap. For the collinear alignment, a detection limit of less than 2 ppmv (water vapor) was achieved, representing a fivefold improvement compared to the crossed-beams configuration. Additionally, a competitive normalized noise-equivalent absorption of 1.95 × 10−9 cm−1W/√Hz was achieved for the collinear configuration. These findings highlight the critical role of beam alignment in optimizing the performance of photothermal interferometry-based sensing systems.

Tu6.93 17:30–19:00 ***Impact of the laser spectral purity on high-resolution distributed acoustic sensing based on optical frequency domain reflectometry***

Clément Charliac[a,b*], Vincent Kemlin[a], Ines Ghorbel[a], Luc Pastur[b], Vincent Crozatier[a];[a]Thales Research & Technology, 1 avenue Augustin Fresnel, Palaiseau, France; [b]Mechanical Engineering Dpt, LMI, ENSTA, Institut Polytechnique de Paris, Palaiseau, France.

We present our recent results on the impact of the laser performances on a high-resolution distributed acoustic sensor using a phase resolved optical frequency domain reflectometry. Two tunable laser sources with equivalent modulation capabilities but different noise characteristics are implemented in an interrogator configured to sense a 1 km fiber with 10 cm spatial resolution at a 3 kHz repetition rate. A deskew filter is used to compensate sweep nonlinearities in post-processing. We first study the impact of the laser noise on static traces, before exciting the fiber with a piezo stretcher at 300 Hz in comparable experimental conditions. We confirm that laser phase noise is limiting the sensing performances once the backscattered intensity is maximized.

Tu6.94 17:30–19:00 ***Microwave frequency OTDR for high strain-rate sensing***

Yan Ren[a], Pedro J. Vidal-Moreno[a], María R. Fernández-Ruiz[a], Sonia Martín-López[a], Luis Costa[b], Zhongwen Zhan[b], Miguel González-Herráez[a]; [a]GRIFO - Sensors and Photonic Technologies, Universidad de Alcalá (UAH), Associate Unit to CSIC by Institute of Optics, 28805 Alcalá de Henares, Spain; [b]Seismological Laboratory, California Institute of Technology, 1200 E. California Boulevard, Pasadena, CA USA 91125-2100

DAS systems have attracted attention from seismology thanks to their ability to perform spatially resolved measurements of the seismic wavefield over tens of kilometers. Conventional DAS systems are limited to measuring small strain rates, which limits their use to the measurement of relatively small events, making DAS systems not appealing for early warning systems. In this paper, a novel DAS system based on microwave frequency OTDR with high saturation strain sensing ability is formulated and demonstrated. The system employs radiofrequency modulation on the probe pulse injected into the fiber. The strain signals caused by large external mechanical perturbations are recovered efficiently. A proof of principle experiment with a perturbation of a few microstrain amplitude and 400 Hz frequency over a distance of 60 meter is well recovered over 4 km fiber, broadening the upper measurement limit of typical DAS, bringing a significant application prospect of extensive, real-time large strain sensing.

Tu6.95 17:30–19:00 ***Signal fading analysis for Φ-OTDR applied in vehicle detection***

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We present a study on the occurrence of signal fading in a φ-OTDR sensor employing a linear-nonlinear preamplification system. After presenting a method to evaluate the incidence of fading, we test how the latter can be minimized by different values of pulse width, both in the laboratory and on a highway bridge in the Netherlands. In addition, we show how this analysis of acoustically induced strain, induced by the passing vehicles, allowed for detection of the number of wheels of the vehicles passing over the bridge.

Tu6.96 17:30–19:00 ***Acoustic resonance sensing of hydrogen diffusion in standard single-mode optical fibers***

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This work investigates hydrogen diffusion in standard single-mode optical fiber (SMF) by analyzing its effect on the resonant frequencies of Transverse Acoustic Mode Resonances (TAMRs). Using Forward Stimulated Brillouin Scattering (FSBS), TAMRs are generated and probed with a continuous-wave laser. The probe laser's polarization, modulated by the acoustic waves, enables monitoring of hydrogen diffusion. Exposure to 50 bars hydrogen pressure reveals a positive frequency shift in the TAMRs, demonstrating their sensitivity to hydrogen permeation into the fiber. This study highlights the potential of TAMRs for hydrogen sensing applications by directly tracking their resonant frequency shift in response to hydrogen diffusion.

Tu6.97 17:30–19:00 ***Acoustic sensing over 100 km using coherent-correlation OTDR and Manchester coding***

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Acoustic sensing using Coherent Correlation Optical Time Domain Reflectometry (CC-OTDR) over 100 km of standard Single-Mode Fiber (SMF) with Manchester coding is demonstrated. This technique achieves a spatial resolution of approximately 10 meters. Integrating sensing capabilities into existing communication fibers allows for efficient monitoring and fault detection. CC-OTDR involves sending optical bit sequences into the fiber and cross-correlating the received Rayleigh backscatter signal with the transmitted signal. Manchester coding enables lower symbol-rates, overcoming limitations of coherent receivers. This work showcases distributed acoustic sensing over 100 km with a 10-meter resolution and detects acoustic events over 400 meters with a 1-2 meter resolution.

Tu6.98 17:30–19:00 ***Influence of Doppler frequency shift induced by environmental perturbations on sensing performance of OFDR***

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Doppler frequency shift due to natural environmental perturbation has recently been considered as an important limit on the sensing performance of optical frequency domain reflectometry. Here we study both theoretically and experimentally the underlying mechanism for the influence of natural perturbations. It is verified that the frequency jitter due to Doppler effect has a more significant impairment than that due to the total delay change within one sweep period. From a practical point of view, it will probably become one dominant noise source and impart a severe limit in precision and effectiveness.

Tu6.99 17:30–19:00 ***Comparison investigation of DAS measurements between fibers in/on the cable for the smartification of optical fiber cables***

Shintaro Nakamoto[a], Daisuke Iida[b], Yoshifumi Wakisak[a,b], Takuji Arihar[a,b], Hiroshi Takahashi[b], Kunihiro Toge[b], Hideaki Murayama[a]; [a]Graduate School of Frontier Sciences, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa-shi, Chiba-ken 277-8561, Japan; [b]Access Network Service Systems Laboratories, NTT Corporation, 1-71, Hanabatake, Tsukuba, Ibaraki-ken, 305-0805, Japan

Distributed acoustic sensing (DAS) with optical fiber cables is becoming a key technology in fields such as infrastructure monitoring and environmental sensing. Unlike conventional DAS methods that primarily utilized dark fibers in the cable, this study explores the use of dedicated sensing fibers, referred to as “skin fiber,” as a novel approach. In this paper, a comparative analysis is conducted to evaluate DAS measurements using both dark fibers and skin fibers, highlighting their respective advantages and limitations. The results indicate that the skin fibers provide higher SNR values and broader frequency response, while dark fibers are affected by various factors, complicating the measurement results.

Tu6.100 17:30–19:00 ***Investigation of metal-coated optical fiber in temperature response using TD-BOCDA***

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In this study, we analyzed the change in Brillouin frequency according to the temperature of metal-coated optical fibers installed in a distributed optical fiber sensor. We used aluminum coated optical fibers for the analysis. The existence of hysteresis was confirmed between the Brillouin frequency changes during the heating and cooling of the metal-coated optical fiber. The Brillouin frequency of the metal-coated optical fiber exhibited a rapid change at an initial 30 °C temperature change region; however, the changes remained constant thereafter. Therefore, the obtained results confirm that metal-coated optical fibers can be used as distributed fiber-optic sensors without hysteresis under continuous heating or cooling conditions.

Tu6.101 17:30–19:00 ***High-speed BOCDA system with dual sidebands for analyzing twodimentional deformation induced by mechanical shock***

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Dual sidebands are newly introduced to a Brillouin optical correlation domain analysis (BOCDA) system as an enhanced configuration for generating orthogonally-polarized probe sidebands (OPS). Pump and probe waves are independently generated as double sidebands of different modulations, effectively minimizing the beat noise from common components and achieving a 37.5% reduction in measurement error. The BOCDA system with dual sidebands is applied to high-speed mapping of the two-dimensional deformation of a wooden board induced by mechanical shock.

Tu6.102 17:30–19:00 ***Quasi-distributed FBG-based temperature measurement of rotating components of electrical motor through fiber optical rotary joint***

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Electrical motors face thermal management challenges under high power conditions, leading to potential thermal degradation and component failure. Traditional temperature sensors often suffer from electromagnetic interference (EMI) and lack precision. This study explores using quasi-distributed fiber Bragg grating (FBG) sensors for thermal performance assessment in an induction motor's rotor. FBGs, known for their EMI immunity and multiplexing capabilities, were mounted using a reliable method and interfaced with a fiber optic rotary joint (FORJ). During steady-state operation at 1500 RPM and 35 Nm torque, an average temperature of 87.62 ± 0.21 °C was recorded with 20 FBG sensors. This high-precision measurement approach enhances thermal management, reduces design iterations, and lowers prototyping costs, ultimately improving motor longevity, performance, and reliability.

Tu6.103 17:30–19:00 ***Rayleigh signature interrogation in time-domain DAS sensors using the short-frequency Fourier transform***

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We present a general method to determine the dependence of Rayleigh backreflection in an optical fiber on position and optical frequency. It is based on applying the so-called short-frequency Fourier transform to signals obtained from coherent optical time-domain reflectometry (COTDR) measurements. The proposed method enables the implementation of distributed acoustic sensors (DAS) with high linearity, spatial resolution, and measurement frequency, while being immune to signal fading. Additionally, the technique is compatible with both conventional COTDR setups and those employing pulse compression, including phase-coded compression waveforms. We experimentally demonstrate the technique with DAS measurements of a 50-km sensing fiber, achieving a 2-m spatial resolution and a sensitivity of 137 pstrain/sqrt(Hz) using a pulse-compression COTDR with a P4 phase-coded compression waveform.

Tu6.104 17:30–19:00 ***Fiber-optic torsion sensing using fiber segment interferometry***

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An interferometric fiber-optic torsion sensing approach based on helical fiber arrangements is presented. The sensors are easy to fabricate and utilize standard single-mode fibers with cleaved ends to provide the interrogated reflection signals, eliminating the need for an inscription process. Two sensor designs with diameters of 6 mm were fabricated and compared based on their sensitivities and temperature compensation capabilities. Sensor-1 features a central core, while Sensor-2 incorporates two counter-rotating helices. Both sensors achieved almost linear readout with noise levels of 3.9 µNmm/√Hz for Sensor-1 and 6.6 µNmm/√Hz for Sensor-2 over bandwidths of 5 kHz. Additionally, Sensor-2 demonstrated a suppression of temperature influence by two orders of magnitude due to the fully differential principle employed. The sensor's design allows for a freely selectable gauge length, making it highly versatile and suitable for a wide range of structural monitoring tasks, either as a stand-alone sensor or integrated within cylindrical structures.

Tu6.105 17:30–19:00 ***Current sensing in phase-OTDR systems using deep learning***

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Phase-sensitive Optical Time Domain Reflectometry (Phase-OTDR) is a widely used technology in acoustic and thermal sensing, but its application in current sensing is limited by photodetector noise, especially for low currents. This study explores the use of deep learning (DL) techniques to enhance the performance of Phase-OTDR-based current sensing systems. Simulated data was generated for current values ranging from 0 A to 99 A, with phase data collected from 401 spatial points along the fiber. Three DL models (1D-CNN, LSTM, and hybrid CNN-LSTM) were applied to classify current levels. The proposed method achieved 100% accuracy for a 20 A difference between current levels, while 97% and 89% accuracies were obtained for 15 A and 10 A differences, respectively. These results demonstrate the potential of DL to improve the accuracy and efficiency of fiber optic current sensing, particularly in distinguishing low and similar current levels under noisy conditions.

Tu6.106 17:30–19:00 ***Phase bias-enhanced Sagnac interferometer for airborne audible sound detection based on 3×3 fiber coupler***

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Conventional detection method of airborne audible sound is predominantly performed using condenser microphones. However, fiber optic interferometers are gaining increasing attention due to their high sensitivity and immunity to electromagnetic interference. Membrane is eliminated in the principle to detect the refractive index modulation of air. Sagnac interferometer has drawn significant interest for its effectiveness in mitigating low-frequency disturbances. This paper investigates the application of a 3×3 fiber coupler to introduce a stable phase bias, significantly enhancing the acoustic sensitivity of the Sagnac interferometer. The theoretical framework underlying this enhancement is discussed, along with experimental results demonstrating the detection of audible sound in the range of 3-5 kHz using an 8 km fiber delay coil. High sensitivity and good signal-to-noise ratio were achieved.

Tu6.107 17:30–19:00 ***Separation of Lamb waves modes using remotely bonded seven-core fiber Bragg grating Fabry–Pérot Interferometer***

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This paper presents the use of a seven-core optical fiber with FBGs written into each core for the unique identification of symmetric vs. antisymmetric Lamb waves traveling in a structure. The Lamb waves are converted into longitudinal and flexural modes that propagate along the optical fiber. An experimental demonstration of the technique is presented and the Lamb waves are also independently measured using a 3D micro-laser Doppler vibrometer for validation.

Tu6.108 17:30–19:00 ***Ultra-low-ZCPs Long-distance OFDR based on compressive sensing technology***

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Long-distance OFDR sensing system requires high zero-crossing points (ZCPs), which imposes significant demands on data acquisition. This paper proposes an ultra-low-ZCPs OFDR based on Compressed Sensing (CS) technology. A dual external clock method and orthogonal matching pursuit (OMP) algorithm are used to overcome the constraint of ZCPs and sensing distance. Experimental results demonstrate that the proposed scheme achieves a sensing distance of 200 meters with fewer than 1M ZCPs per sampling channel. Compared to other solutions achieving hundred-meter-level sensing distances, the ZCPs are reduced by an order of magnitude.

Tu6.109 17:30–19:00 ***Harnessing speckle optical fiber sensors through high-frequency interrogation with an event-based camera***

Tomás Lopes[a,b,*], Joana Teixeira[a,b], Vicente V. Rocha[a,b], Tiago D. Ferreira[a,b], Catarina S. Monteiro[a,b], Pedro A. S. Jorge[a,b], and Nuno A. Silva[a,b]; [a]Department of Physics and Astronomy, Faculty of Sciences, University of Porto, Rua do Campo Alegre s/n, 4169-007 Porto, Portugal; [b]INESC TEC, Centre for Applied Photonics, Rua do Campo Alegre 687, 4169-007 Porto, Portugal. *tomas.j.lopes@inesctec.pt

Speckle-based fiber optical sensors are highly sensitive but typically constrained by camera frame rates and dynamic range. Recent advancements in event-based vision sensors (EVS) offer a promising solution, enabling high-speed, low-latency detection of dynamic illumination changes with frequency responses up to the MHz range. This study explores the use of EVS as an interrogator for a speckle-based optical fiber sensor operating at 532 nm to detect vibrations induced by a standard sound speaker. Vibrations in contact with the fiber produce dynamic speckle pattern changes, tracked by the EVS and processed into temporal frames with timestamps below 100 µs. By approximating the deformation's differential operator in the linear regime, the acoustic signal is successfully reconstructed in two cases: a 1.2 kHz single-frequency signal and a linear ramp from 300 Hz to 2.5 kHz. Results highlight accurate identification of fundamental frequencies and harmonics, expanding possibilities for dynamic sensing and optical metrology.

Tu6.110 17:30–19:00 ***Enhancement of DAS sensitivity with acoustic metasurface***

Qiang Jing, Jiahao Wang, Qiyun Zhang, Rong Tang, Sijin Zheng, Zengling Ran, Yunjiang Rao*; Fiber Optics Research Center, Key Laboratory of Optical Fiber Sensing and Communications, University of Electronic Science and Technology of China, Chengdu 611731, China.yjrao@uestc.edu.cn

Distributed acoustic sensing (DAS) technology converts the existing fiber optic telecom cables or customized sensing cables into dense microphone arrays. Despite the research undertaken on cable structures, materials, and DAS interrogator, the adoption of passive acoustic manipulation array for enhancing acoustic sensitivity remains unexplored. In this study, we present a novel concept for improving the sensitivity of DAS with acoustic metasurface. The tapered labyrinthine structures are utilized in the construction of the '0' and '1' elements of the coding metasurface, which constitutes an acoustic lens. The sensitivity enhancement is achieved through the focusing of incident waves after the manipulation of acoustic metasurface. The simulated and experimental results demonstrate that the DAS sensitivity is significantly enhanced by approximately 10 dB across a frequency range of 810 Hz. This work demonstrates the feasibility of an acoustic metasurface-based DAS and its potential for applications in the detection of weak airborne, or underwater acoustic signals.

Wednesday May 28th 2025

W1 Plenary Session II

CHAIR **Prof Tong Sun**
City St George´s, University of London (United Kingdom)

W1.1 8:30-9:30 **Dr. Stuart Russell**
Sintela Ltd (United Kingdom)

Distributed Acoustic Sensing (DAS) a Real-World Perspective, Requirements, Applications and Techniques

This talk presents a brief history of the development of Distributed Acoustic Sensing (DAS) systems utilizing Rayleigh scatter. We then describe some of the technical issues associated with coherent detection DAS topologies before presenting results using novel optical and signal processing techniques employed by Sintela in their Onyx platform. We demonstrate noise floors of <-81dB rads/(Hz)$^{1/2}$ and -90dB rads/(Hz)$^{1/2}$ operating at 6.4m resolution at 20kHz on 5km of standard SMF-28e+ fiber and enhanced scatter fiber respectively. The same system when deployed on OFS Scuba-110 ULL fiber exhibiting a loss of 0.146dB/km, is capable of operation over ranges of 180km, with a spatial resolution of only 10m. Novel real-world applications of DAS are discussed before giving the authors perspective on the research and development path which future DAS sensors may take in the short to mid-term in order to address the current limitations observed in current DAS applications

W2 Session 9h30–11h00 *Integrated Photonics, Cavity Optomechanics and Quantum Sensing*

CHAIRS **Prof. Fumihiko Ito**
Shimane University (Japan)

Dr. Rainer Engelbrecht
Technische Hochschule Nurenberg (Germany)

W2.1 9:30–10:00 INVITED **Prof. Stefanie Kroker**
Technische Universität Braunschweig (Germany)

Bringing Atoms and Ions onto a Chip: Integrated Photonics for Compact and Robust Quantum Technologies

Integrated photonics plays a crucial role in enabling compact photonic systems for light routing and conditioning, incorporating increasingly complex optical functions. By offering scalability in both ensemble size and system complexity, it holds great promise for developing compact and robust quantum technologies. In this talk, I will provide an overview of integrated photonic devices for quantum sensing and quantum computing with trapped atoms and ions. I will discuss the physical requirements and key material considerations essential for these applications.

W2.2 10:00–10:15 ***Silicon photonics MIOC with forward-biased phase modulators for closed-loop operation in an interferometric fiber optic gyroscope***

Jen-Shu Lo[1], Bo-Yu Su[1], Wei-Xuan Chen[1], Chia-Chien Wei[1]*, Yung-Jr Hung1**, Quan-Hsiang Tseng[2], Tz-Shiuan Peng[2]; [1]Dept. of Photonics, National Sun Yat-sen University, No. 70, Lienhai Rd., Kaohsiung, Taiwan; [2]Missile & Rocket Systems Research Division, National Chung-Shan Institute of Science & Technology (NCSIST), No. 481, Zhongzheng Rd., Taoyuan, Taiwan. *ccwei@mail.nsysu.edu.tw; **yungjr@mail.nsysu.edu.tw

We present a Si-MIOC incorporating forward-biased pn junction phase modulators, designed for potential use in closed-loop IFOGs. These modulators demonstrate a broad linear phase modulation range under forward bias, effectively addressing the dynamic range limitations commonly associated with silicon modulators. By implementing phase ramp modulation, we induced controlled phase differences, confirming the modulators' capability to support phase nulling in closed-loop operation and establishing the feasibility of utilizing Si-MIOCs for closed-loop IFOG applications.

W2.3 10:15–10:30 ***Ultra-sensitive monolithically integrated tri-axial fiber-optic accelerometer with a nano-g level noise floor***

Minzhi Hong, Chaotan Sima*, Kuangqi Li, Jiakang Xu, Yuhan Xiao, Ping Lu; Next Generation Internet Access National Engineering Research Center, School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan 430074, China.*smct@hust.edu.cn

In this paper, we propose and demonstrate a nano-g level monolithically integrated tri-axial fiber-optic accelerometer. The tri-axial sensing units are integrated into a silicon-based chip, incorporating improved spring-mass structures that significantly increase sensitivity. Moreover, the chip behaves with a uniform thickness of 460 um, greatly simplifying the fabrication process. Acceleration signals are retrieved using fiber-based Fabry-Perot interferometers (FPIs) and optical phase demodulation. Within the operating bandwidth of 1~64 Hz, the sensitivities of the in-plane and out-of-plane sensing units exceed 43.6 dB (151.4 rad/g) and 42.8 dB (138.7 rad/g), respectively. The average noise floor of the tri-axial units is measured to be as low as 22.82 ng/Hz1/2. The results indicate that the proposed fiber-optic accelerometer is highly promising for applications in low-frequency micro seismic monitoring applications.

W2.4 10:30–10:45 ***PDMS-based flexible distributed tactile sensor in a multi-waveguide system fabricated***

Y. Yin[a], T. Ishigure[b]; [a]Graduate School of Science and Technology, Keio university, Yokohama, Japan 223-8522; [b]Faculty of Science and Technology, Keio university, Yokohama, Japan 223-8522

Recentlly, researchers more commonly use fiber Bragg gratings which structure is relatively complex when preparing pressure sensors. In this paper, a 4 waveguides sensor system is proposed. The array features an optimized geometry obtained through beam propagation method (BPM) simulation. UV curable poly dimethyl siloxane (PDMS) is employed as the cladding to control the mechanical flexibility. When pressure is applied at different locations on the waveguide, the amount and location of applied pressure can be precisely sensed by incremental insertion loss at each end of the different channels. Main principle for accurate sensing of this sensor is the bending losses. The experimental results show that the sensitivities of 4 channels in a fabricated sensor are 8.7 dB/MPa, 10.73 dB/MPa, 9.2 dB/MPa and 10.88 dB/MPa, respectively in a range of 0-1.13 MPa. Additionally, we propose a 3D crossed waveguide structure as a potential direction for future development.

W2.5 10:45–11:00 ***Role of thin film refractive index contrast in the design and performance of nano-photonic crystal D-shaped fiber devices for label-free biosensing***

Ignacio Del Villar[a,b], Esteban Gonzalez-Valencia[c,d], Norbert Kwietniewski[e], Dariusz Burnat[e], Claudia Borri[f], Rukmani Singhf, Shadab Dabagh[f], Dayron Armas[a], Emil Pituła[e], Monika Janik[e], Ignacio R. Matías[a,b], Ambra Giannetti[f], Pedro Torres[d], Mateusz Śmietana[e,g], Francesco Chiavaioli[f]*; [a]Electrical, Electronic and Communications Engineering Department, Public University of Navarre, Pamplona 31006, Spain; [b] Institute of Smart Cities (ISC), Public University of Navarra, 31006 Pamplona, Spain; [c]Department of Electronic and Telecommunications Engineering, Instituto Tecnológico Metropolitano, Medellín, Colombia; [d]Escuela de Física, Universidad Nacional de Colombia - Sede Medellín, A.A. 3840 Medellín, Colombia; [e]Warsaw University of Technology, Institute of Microelectronics and Optoelectronics, 00-662, Warszawa, Poland; [f]National Research Council of Italy (CNR), Institute of Applied Physics "Nello Carrara", 50019 Sesto Fiorentino, Italy; [g]Łukasiewicz Research Network – Institute of Microelectronics and Photonics, Department of Glass, al. Lotników 32/46, 02-668 Warsaw, Poland. *f.chiavaioli@ifac.cnr.it

Achieving a high figure of merit alongside exceptional sensitivity is critical for advancing optical biosensors capable of ultra-low limits of detection. In this work, we investigate the performance of D-shaped single-mode fiber devices coated with 1D photonic crystal stacks. These nano-assembled layers, composed of alternating high- and low-refractive-index (RI) materials, enable the excitation of Bloch surface waves (BSWs). By systematically varying the RI contrast between the layers, we demonstrate that while a moderate increase in RI contrast improves sensitivity and narrows the full width at half maximum (FWHM) of the BSW resonance, the sensitivity tends to stabilized as we further increase the RI contrast, while the FWHM still can be pushed towards a higher FoM. Real-world applicability is validated through the detection of immunoglobulin G (IgG) at record-low concentrations of 70 aM, leveraging the solution as a versatile, operando, high-performance biosensing platform.

W3 Session ***Micro-Nano Sensors***

11h30–13h00

CHAIRS **Prof. Moshe Tur**
Tel Aviv University (Israel)

Prof. Yosuke Mizuno
Yokohama National University (Japan)

W3.1 11:30–12:00 **Prof. Brant Gibson**
INVITED RMIT University (Australia)

Diamond-Doped Optical Fibres for Magnetometry Applications

The ability to persistently monitor weak magnetic fields is a key objective in long-term surveillance. One approach to meeting this goal is the development of optical fibre-based magnetometers capable of remote operation. Diamond containing the negatively-charged nitrogen vacancy colour centre (NV) is emerging as an important system for the sensing of various physical parameters including magnetic field and temperature. Many existing diamond NV magnetometers require complex microscopes to monitor the fluorescence signal, which can restrict NV to laboratory settings. Here I will discuss the fabrication and characterization of an intrinsically magneto-sensitive optical fibre with potential applications including remote magnetic field sensing. The hybrid fibre allows for optical interrogation of NV-spin states via bound modes in a highly-stable waveguide structure. Our results open the possibility of robust, field-deployable fibre optical magnetometry for a broad range of quantum sensing applications.

W3.2 12:00–12:15 ***Effect of TiO2 Coating on Neutron Response of UV-written B-Ge co-doped Optical Fiber Long Period Gratings***

Lorenzo Scherino[a], Gaia Maria Berruti[b], Patrizio Vaiano[b], Giuseppe Quero[b], Simona Zuppolini[c], Aldobenedetto Zotti[c], Mauro Zarrelli[c], Anna Borriello[c], Paolo Petagna[a], Andrea Cusano[b]*, Marco Consales[b]*; [a]European Organization for Nuclear Research, Dept. of Experimental Physics, Geneva CH-1211; [b]University of Sannio, Dept. of Engineering, Benevento I-82100; [c]National Research Council, Institute for Polymers, Composites and Biomaterials, Portici, Naples, I-80055. *consales@unisannio.it, acusano@unisannio.it

This contribution presents the response to neutron irradiation of Long Period Gratings (LPGs) inscribed in a B/Ge co-doped optical fiber by means of an excimer laser. The effect of a nanoscale titanium dioxide (TiO2) coating is discussed. The experiment was conducted in the TRIGA MARK II research reactor of the Jožef Stefan Institute in Ljubljana, where the optical fiber devices were subjected to a total accumulated fluence of approximately 3.4×10^{15} n/cm². The impact of neutron irradiation on the spectral responses of the LPGs under analysis was investigated in terms of both radiation-induced shifts and changes in visibility. The presented results highlight the potential of nanoscale layers to modulate the sensitivity of LPG-based devices to radiation, thus providing a pathway for tailoring their response in specific applications of radiation dosimetry and in neutron rich environments.

W3.3 12:15–12:30 ***Ultra-sensitive gas detection using noise-canceled graphene-microcavity-based fiber laser sensor***

Yuchen Wang[a], Yiwei Li[a], Zihan Liu[a], Zeping Wang[a], Yanhong Guoa, Teng Tan[a], Yunjiang Rao*[a], Baicheng Yao*[a,b]; [a]Key Laboratory of Optical Fiber Sensing and Communications (Education Ministry of China), University of Electronic Science and Technology of China, Chengdu 611731, China; [b]Engineering Center of Integrated Optoelectronic & Radio Meta-chips, University of Electronic Science and Technology, Chengdu, China. *yjrao@uestc.edu.cn; yaobaicheng@uestc.edu.cn

We demonstrate an in-microcavity fiber laser sensor by combining the dual laser co-generation-based common noise canceling effect and the graphene-based sensitivity enhancement. We use a single 980 nm pump that generates an orthogonally polarized laser pair in degeneracy-breaking modes, producing a heterodyne beat signal at 118.96 MHz with a linewidth of 930 Hz in vacuum. The frequency noise is reduced to 200 Hz²/Hz at a 1 MHz offset. This compact device enables ultrasensitive ammonia detection, achieving a detection limit of 2 pMol/L in vacuum and 0.01 ppb in air. Such integration of graphene optoelectronics and microcavity photonics on fiber offers a new approach for micro-laser control and in-situ optical fiber sensing.

W3.4 12:30–12:45 ***Ultra-high resolution fiber laser strain sensor based on optical injection phase-lock loop***

Wei Jin[a,b], Jiaxing Gao[a,b], Mengyao Zhanga[b], Yifei Lu[a,b], Yu Zhang*[a,b], Zhihai Liu*[a,b]; [a]Key Laboratory of In-Fiber Integrated Optics, Ministry of Education, Harbin Engineering University, Harbin 150001, P. R. China; [b]Key Laboratory of Photonic Materials and Device Physics for Oceanic Applications, Ministry of Industry and Information Technology of China, Harbin Engineering University, Harbin 150001, P. R. China.*zhangy0673@163.com, *liuzhihai@hrbeu.edu.cn

We propose an ultrahigh resolution distributed-feedback fiber laser (DFB-FL) based strain sensor based on optical injection phase-lock loop (OIPLL). For optical injection-locking (OIL) path, we obtain a high quasi-strain spectral resolution of 2.16 pε/√Hz at 80 Hz, and for optical phase-locked loop (OPLL) path we realize an ultrahigh dynamic strain spectral resolution of 125.89 fε/√Hz at 1 kHz at the same time, which appears to be extremely auspicious for applications in geophysical research.

W3.5 12:45–13:00 ***A graphene micro-rod resonator gas sensor with switchable selectivity***

Hao Zhang[a], Shuya Yuan[a], Fan Tang[a], Yanhong Guo[a], Guangming Zhao[b], Teng Tan[a]*, Yunjiang Rao*[a], Baicheng Yao*[a]; [a]Key Laboratory of Optical Fiber Sensing and Communications (Education Ministry of China), University of Electronic Science and Technology of China, Chengdu 611731, China; [b]Institute of Semiconductors, Chinese Academy of Science, Beijing 100083, China.*taurus_tan@uestc.edu.cn; yjrao@uestc.edu.cn; yaobaicheng@uestc.edu.cn

We present a gas sensor that combines functionalized graphene within a micro-rod resonator, featuring a low threshold, simple structure, easy operation, high sensitivity, and switchable selectivity. By monitoring the shift in the resonant mode due to the adsorption of gas molecules, we achieved detect limit of 1.1 ppb for NH3 and CO2 using a P-doped graphene-functionalized microcavity, while we demonstrated detect limit of 4 ppb for NO2 by simply altering the graphene doping from P to N. Our approach highlights the advantages of low cost and flexibility, offering a promising solution for high-performance fiber-cavity architectures for chemical sensing.

W4 Session *Smart Structures*

14h00–15h30

CHAIRS

Prof. Jean Carlos Cardozo da Silva
University Tecnológica Federal do Paraná (Brazil)

Prof. Hideaki Murayama
The University of Tokyo (Japan)

W4.1 14:00–14:30 **Dr. Mikael Mazur**
INVITED Nokia Bell Labs (United States of America)

Fiber Sensing using Live Fibers in the Deployed Fiber Grid

In this work we focus on fiber sensing using the deployed telecommunication grid. Sensing using telecom transceivers as well as dedicated distributed fiber sensing systems are covered. We discuss the challenges around using already deployed fiber, both from a compatibility and sensitivity perspective. Specifically, we focus on how to avoid any degradation on the telecom signals from introducing fiber sensing, a vital requirement for large scale deployment.

We present results from several field experiments over lit fibers (co-propagating data channels), focusing on two main use-cases. First, how can fiber sensing tools and techniques be introduced to increase the reliability of the optical communication network. Second, how can subsea cables be leveraged for monitoring today's unmonitored deep oceans, focusing primarily on climate change and seismic detection.

W4.2 14:30–14:45 ***High-precision colonoscope image guidance using OFDR shape sensing with right-angle core configuration in multicore fiber***

Zhou Xu[1], Tianle Chen[1], Lei Tu[2], Liang Wang[1*], and Ming Tang[1]; [1]School of Optics and Electronic Information, Huazhong University of Science and Technology, Wuhan 430074, China [2]Division of Gastroenterology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China. *hustwl@hust.edu.cn

High-precision colonoscope image guidance using OFDR shape sensing with right-angle core configuration and cosine similarity algorithm is proposed for the first time. The inter-core sensing point misalignment is well corrected and accurate fiber twisting compensation is enabled. Experiment results show less than 1.55% relative error and 2.5 times accuracy improvement when compared with traditional equilateral-triangle core configuration, and the reconstructed shape of the colonoscope matches well with the real shape inside the human intestinal model.

W4.3 14:45–15:00 ***Simultaneous distributed acoustic and temperature sensing for robust leakage detection in gas pipelines***

V Panand[a,b], Neethu Sasikumar[a], V R Ranjith[a], Arsath Abbasali Ayubali[a], Sachit Sekhar Patra[a], and Balaji Srinivasan[a] ; [a]Indian Institute of Technology, Madras, Chennai, India; [b]CSIR Central Scientific Instruments Organisation, Chennai, India.

We report a comprehensive study carried out for the robust detection of leakages in gas pipelines based on simultaneous distributed sensing of acoustics and temperature (DAS/DTS) due to the leakage event. The specific acoustic and temperature signatures corresponding to the leakage event have been simulated using a computational fluid dynamics (CFD) model. The detection of such signatures through a simultaneous DAS/DTS measurement system are then simulated using a numerical model of the DAS/DTS system. Finally, the simulation results are experimentally validated using controlled experiments over a 43 km long standard telecom-grade singlemode optical fiber cable (OFC) with a spatial resolution of 10 m.

W4.4 15:00–15:15 ***Novel sensing network based on seamless integration of DAS and PON***

Rong Tang, Sijin Zheng, Qiang Jing, Shengtao Zou, Tianyu Hua, Yunjiang Rao*; Fiber Optics Research center, Key Laboratory of Optical Fiber Sensing and Communications, University of Electronic Science and Technology of China, Chengdu 611731, China.*yjrao@uestc.edu.cn

Passive optical network (PON), as the backbone of optical fiber telecommunication networks, has been widely deployed in residential areas, urban centers and transportation infrastructures. When integrated with distributed acoustic sensing (DAS) technology, optical fibers in PON can be turned into a sensing network for real-time safety monitoring and early warning of facilities nearby. Here, we propose and demonstrate a sensing network based on the seamless integration of DAS and existing PON, by using an integrated time-varying frequency-shifted sensing-communication signal modulation format (ITVFS-SCSM), for the first time. The ability of ITVFS-SCSM that shares the signal generation and transmission equipment in PON is validated by experiment and a sensing sensitivity of 36.5 pε/√Hz@55Hz over a 25.45 km distance is achieved without any influence on the communication quality of PON. Such a novel sensing network based on the seamless integration of DAS and PON may lead to a new generation of PON-based sensing networks for use in real-time security monitoring and infrastructure management, etc.

W4.5 15:15–15:30 ***Beam shaping the evanescent field for distributed fluorescence--based optical fibre sensing***

S. C Warren-Smith*[a,b,c], X. Li[d], C. M. B. Cordeiro[e], Dale E. Otten[b] David G. Lancaster[b], H. Ebendorff-Heidepriem[c], and L. V. Nguyen[a,b,c]; [a]Future Industries Institute, University of South Australia, Mawson Lakes, South Australia 5095, Australia; [b]Laser Physics and Photonics Devices Laboratories, UniSA STEM, University of South Australia, Mawson Lakes, South Australia 5095, Australia; [c]Institute for Photonics & Advanced Sensing, The University of Adelaide, North Terrace, South Australia 5005, Australia; [d]College of Information Science and Engineering, Northeastern University, Shenyang, Liaoning 110819, China; [e]Gleb Wataghin" Institute of Physics, University of Campinas, Campinas 13083-859, Brazil.*stephen.warren-smith@unisa.edu.au

High resolution distributed chemical and biological sensing will enable new discoveries in biological and biomedical applications. Single-point chemical and biological optical fibre sensors often utilise fluorescence-based approaches, which allows high sensitivity and specificity. Achieving distributed sensing at a biologically relevant resolution (< cm) is hindered by the incoherent nature of fluorescence emission. Wavefront shaping of the excitation light in a multimode exposed-core microstructured optical fibre is a promising technique to enhance spatial selectivity by controlling the fluorescence excitation region. We present proof-of-concept numerical and experimental results where we enhance the evanescent field at selected locations along the fibre, and discuss the potential for enhancement by using multi-photon fluorescence.

W5
16h00–17h30

Poster Session II
Novel Concepts/Materials/Gratings/ Micro-Nano/Smart Structures

W5.1 16:00–17:30 ***Optical fiber macrobend sensor assisted by artificial intelligence for monitoring a flexible structure***

Vinicius de Carvalho*, André Eugenio Lazzaretti, Marcia Muller, José Luís Fabris; Graduate Program in Electrical and Computer Engineering, Universidade Tecnológica Federal do Paraná, Av. Sete de Setembro, 3165, Curitiba, PR, 80230-901, Brazil. *crvlh.v@gmail.com

In this work, a multiple-macrobend sensor consisting in an optical fiber spiral was integrated into a cylindrical flexible structure with a length of 15.0 cm. When the structure is bent, the changes observed in the transmittance of the coiled fiber within the 475 - 750 nm spectral range allow the sensor operation. The cylinder was suspended by one of its extremities, and the free tip was moved in the xy-plane. Machine learning methods used for data processing resulted in an average error of less than 0.6 cm for a total range of 10 cm in detecting the position of the structure's free extremity. This result and the tests carried out under repeatability conditions indicate the sensor's potential for deformation monitoring.

W5.2 16:00–17:30 ***Homogenizing fibre optic for plasma emission in multichannel LIBS spectrometry***

J. F. Algorri[1,2,3,*], M. G. Fernández-Manteca[3], L. Rodriguez-Cobo[2] J.M López-Higuera[1,2,3] and A. Cobo[1,2,3] ; [1]Photonics Engineering Group, Universidad de Cantabria, 39005, Santander, Spain; [2]CIBER-bbn, Instituto de Salud Carlos III, 28029, Madrid, Spain; [3]Instituto de Investigación Sanitaria Valdecilla (IDIVAL), 39011, Santander, Spain. *algorrijf@unican.es

In this work, we propose a novel approach for plasma collection in Laser-Induced Breakdown Spectroscopy (LIBS). Our method aims to achieve better homogenization than traditional methods, especially in the context of a heterogeneous plume.

W5.3 16:00–17:30 ***Analysis of the effects of temperature, strain and refractive index in long-period fiber grating used for epoxy resin cure monitoring***

Oleg V. Ivanov*, Kaushal Bhavsar, James M. Gilbert; University of Hull, Hull, United Kingdom HU6 7RX.*olegivvit@yandex.ru

We analyze the spectral response of long-period fiber gratings in epoxy resins to temperature, strain and refractive index. Wavelength shifts and dip amplitudes of cladding mode notches are monitored and are used to decouple temperature, strain and refractive index by employing a weighted pseudo inverse matrix. We propose a new model to describe the influence of fiber parameters and external refractive index, temperature and strain on spectral behavior of long-period fiber gratings in epoxy resins during hardening.

W5.4 16:00–17:30 ***A low-noise Brillouin/erbium fiber laser module for optical sensing***

Mo Chen*, Jiaze Zhao, Jianfei Wang, Yang Lu, Xiaoyang Hu and Zhou Meng; College of Meteorology and Oceanography, National University of Defense Tchnology, Changsha, Hunan, China.*suiningchenmo@163.com

We demonstrate a low-noise Brillouin/erbium fiber laser module. The size of the module is 143 mm×113 mm×30 mm. Its output power is 16 mW. Its phase noise at 1 kHz is -142 dB re rad/Hz1/2 (normalized to 1 m optical path difference). This low-noise fiber laser module presents important applications in many highly coherent optical fiber sensing systems.

W5.5 16:00–17:30 ***Hyperbolic metamaterial enhancement based high sensitivity sidepolished fiber SPR sensors***

Shiqi Hu[a,b], Yaofei Chen[b], Gui-shi Liu[b], Lei Chen[b], Yunhan Luo[b*], Zhe Chen[b,c*]; [a]The Affiliated Guangdong Second Provincial General Hospital of Jinan University, Guangzhou 510632, P.R. China; [b]Department of Optoelectronic Engineering, Jinan University, Guangzhou China, 510632; [c]JiHua Laboratory, Foshan, Guangdong, China, 528200. *yunhanluo@163.com; thzhechen@163.com

A high-performance surface plasmon resonance (SPR) fiber sensor is proposed with hyperbolic metamaterials (HMMs), nano-diamond (NDs), and polydimethylsiloxane (PDMS) to enhance the temperature sensitivity and response speed. The HMM with tunable dispersion can break through the structural limitations of optical fiber to improve the refractive index (RI) sensitivity, while NDs and PDMS with large thermo-optic coefficients enable to induce significant RI change under varied thermal fields. The ternary composite endows the sensor with high-temperature sensitivity of -9.021 nm/°C, which is 28.6 times higher than that of the conventional gold film-based SPR sensor. Furthermore, NDs with high thermal conductivity (2200 W/mK) effectively expedite the thermal response of PDMS, which reduces the response time from 80 to 6 s. It is believed that the proposed sensors with high sensitivity, fast response time, and compact size have great potential for applications in industrial production, healthcare, environmental monitoring, etc.

W5.6 16:00–17:30 ***Exchangeable scanning probe microscopy optical fiber tips***

L. Zezulka*[a,b], Z. Nováčeka[b], M. Konečnýa[b], M. Matějka[c], Š. Černý[d], J. Spousta[a,b], T. Šikola[a,b]; [a]Brno University of Technology, Faculty of Mechanical Engineering, Institute of Physical Engineering, Brno 61669, Czech Republic; [b]Brno University of Technology, Central European Institute of Technology, Purkyňova 123, 61200 Brno, Czech Republic; [c]Institute of Scientific Instruments of the Czech Academy of Sciences, Královopolská 147, 61264 Brno, Czech Republic; [d]IQS nano s.r.o., Hlavní 130, 25068, Husinec, Czech Republic.*Lukas.Zezulka@vut.cz

Correlative probe, electron, and near-field cathodoluminescence microscopy in scanning electron microscope (SEM) enables complementary sample characterization and chemical analysis. In this technique, scanning near-field optical microscopy (SNOM) probe scans the sample simultaneously with the electron beam, acquiring the correlated images. However, the system's added complexity and the fragility of the SNOM tip have yet limited the widespread adoption of this technique. We present a probe for the AFM-in-SEM solution LiteScope featuring an optical fiber with an exchangeable

tip. This probe-tip system allows seamless in situ SEM replacement of only the tip at the optical fiber's end, without venting the vacuum chamber. These exchangeable tips are fabricated using two-photon polymerization and post-processed with plasma etching. Proof-of-concept cathodoluminescence and topography measurements are presented. The presented solution streamlines the workflow of the correlative probe, electron, and near-field CL microscopy and broadens the applicability of optical fiber functionalization for diverse experimental setups.

W5.7 16:00–17:30 ***BNNT coating of FBGs written in tapered optical fiber for hydrophilic gas sensing***

Ping Lu*, Jingwen Guan, Huimin Ding, Kasthuri De Silva, Christopher Kingston, and Stephen J. Mihailov; National Research Council Canada, Quantum and Nanotechnologies Research Center, 100 Sussex Drive, Ottawa, ON K1A 0R6, Canada.*ping.lu@nrc-cnrc.gc.ca

Fiber Bragg gratings (FBGs) were fabricated in tapered fibers using the plane-by-plane technique and a fs-IR laser. A thin layer of boron nitride nanotubes (BNNTs) was deposited onto the FBGs through a dip-coating process. The reflection spectra of FBGs were then recorded when they were placed above a water solution of ammonia (NH3), hydrogen chloride (HCl) or liquid bromine (Br2) in an open cylinder container. It was demonstrated experimentally that, due to the thin BNNT coating, the returned losses of FBGs were increased when they were surrounded with such hydrophilic gas vapors, such as ammonia, bromine and hydrogen chloride. The results of this work indicates that BNNT coating on FBGs plays an important role for hydrophilic gas detection with high sensitivity and reusability due to their quick release of adsorbed gases. The proposed sensor has the capacity of multiparameter sensing and can be used in harsh environments.

W5.8 16:00–17:30 ***Two-dimensional force sensing whisker based on a WGM microbubble resonator***

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This study presents an all-optical 2D force sensor based on cascaded whispering gallery mode (WGM) microbubble resonators (MBRs). By using a characteristic sensing matrix to decouple cross-sensitivity of 2D forces, the sensor achieves high sensitivities to force of 118.14 pm/mN in the x direction and 177.12 pm/mN in the y direction. This work demonstrates the potential of WGM-based 2D force sensors for applications in robotics, artificial perception, and biomedical devices.

W5.9 16:00–17:30 ***Fiber optical sensor for structural strain and displacement monitoring of large power generation facilities***

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In some applications electrical strain and displacements sensors cannot be used due to the strong electromagnetic fields or local discharges. Among these are electrical engines such as power generators and wind turbine blades. The paper presents a novel FBG based bending sensor for accurate and reliable measurement of displacements and strain of large structures.

W5.10 16:00–17:30 ***Expressway embankment health monitoring by DAS measurement***

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Linear microtremor array measurements using geophones and DAS measurements using optical fiber cables utilizing vibrations of passing vehicles were carried out on two embankments of the expressway. In DAS measurements on roads with high traffic vibration, increasing more measurement time is less effective in improving the accuracy of analysis. On the other hand, it is found that we can extract long-wavelength surface waves, if the gauge length is increased. We were able to analyze the S-wave velocity structure at a depth of about 15 m by extracting a phase velocity curve geometrically below 60 Hz from a strain velocity waveform of a few minutes with a gage length of 5 m. DAS results are compatible with the S-wave velocity structure obtained by linear microtremor array measurements. Therefore, DAS is fully useful for screening areas with low rigidity and weak areas in expressway embankments.

W5.11 16:00–17:30 ***Unraveling the generation dynamics of Brillouin-Kerr microcomb using a harmonically synchronized time magnifie***

Junting Du[a], Wenxuan Lian[a], Zhangru Shi[a], Kunpeng Jia[b], Zhenda Xie[b], Baicheng Yao[a], Mingming Nie[a,*], Bowen Li[a,*], Yunjiang Rao[a] ; [a]Key Laboratory of Optical Fiber Sensing and Communications (Education Ministry of China), University of Electronic Science and Technology of China, Chengdu 611731, China; [b]National Laboratory of Solid State Microstructures, School of Electronic Science and Engineering, Nanjing University, Nanjing 210093, China. *mingming.nie@uestc.edu.cn; bowen.li@uestc.edu.cn

Dissipative Kerr soliton microcombs has become a revolutionary technology for diverse sensing applications. The Brillouin-Kerr soliton microcombs, with sub-femtosecond timing jitter under free-running conditions, shows great potential to serve ultra-precision optical sensing without excessive system complexity. However, due to the bandwidth limitations in opto-electronic detection equipment, its ultrafast dynamic generation process has never been clearly characterized experimentally. Here, we have constructed a harmonically synchronized time magnifier capable of single-short waveform characterization with sub-ps time resolution and flexibly tunable measurement frame rate and observed the dynamic of BKS initiation from a flat background along with the real-time dynamics of controlling the generation of different numbers of solitons. This provides long-sought experimental verification for the theoretical study of BKS and enriches the physical understanding of the excitation process, which paves the way towards the practical application of ultra-low noise BKS microcomb in precision optical sensing.

W5.12 16:00–17:30 ***Fiber-enhanced Fourier-transform photothermal spectroscopy for multi-component gas sensing***

Linhao Guo[1], Pengcheng Zhao[1], Haihong Bao[1,2], Jingwen Wu[1,2], Shoufei Gao[3], Yingying Wang[3], Hoi Lut Ho[1,2], Shoulin Jiang[2], and Wei Jin[1,2]; [1]Department of Electrical and Electronic Engineering, The Hong Kong Polytechnic University, Hong Kong, China; [2]Photonics Research Center, The Hong Kong Polytechnic University Shenzhen Research Institute, Shenzhen 518057, China; 3Institute of Photonics Technology, Jinan University, Guangzhou 510632, China.

We present Fourier transform photothermal spectroscopy (FT-PTS) with a hollow-core fiber (HCF) absorption cell for gas sensing. The technique combines the features of the Fourier transform infrared spectroscopy and the fiber-enhanced photothermal spectroscopy, and requires only a single HCF absorption cell and one broadband light source covering the absorption spectra of multiple gas components. With a 10-cm-long hollow-core conjoint-tube fiber (HC-CTF), we have demonstrated the detection of acetylene (C2H2), carbon dioxide (CO2) and a mixture of C2H2 and CO2, with the measured absorption spectra corresponding well to the calculated spectra based on the HITRAN database.

W5.13 16:00–17:30 **Sound detection and recognition based on biomimetic fiber--microcavity acoustic sensors**

Xinyue He[a], Zeping Wang[a], Wenchao He[a], Sipei Liu[b], Siqin Ge[b], Teng Tan[a], Yunjiang Rao[a], Yu Wu[a,*], Baicheng Yao[a,*]; [a]Key Laboratory of Optical Fiber Sensing and Communications (Education Ministry of China), University of Electronic Science and Technology of China, Chengdu 611731, China; [b]Institute of zoology, Chinese Academy of Sciences, China. *yaobaicheng@uestc.edu.cn; *wuyu@uestc.edu.cn

Inspired by the tympanum structures of insects, we present miniature biomimetic Fabry-Perot fiber-microcavity acoustic sensors. These sensors incorporate 3 types of biomimetic nano-structured diaphragms and achieve a maximum signal-to-noise ratio of 84.3 dB, allowing for the detection of pressure as low as 1.6 μPa/Hz^(1/2). Moreover, the biomimetic fiber acoustic sensors exhibit varied spectral responses, offering a way to obtain more detailed sound information. By synchronizing the three sensor types and integrating them with neural networks, we develop high-accuracy acoustic recognition for human speech, achieving an identification error of less than 0.3%.

W5.14 16:00–17:30 ***NN-recognition algorithm with gaussian activation function adjusted to probability range for fiber vibration multi-classification***

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We propose a simple neural network algorithm with Gaussian activation function to realize an artificial neuron for optical fiber vibration recognition. The Gaussian function parameters are coordinated so that the inputs to the function return only value close to the probability range. This approach provides a suitable training process for classifying small numbers of classes in distributed acoustic sensing (DAS) on field communication cable.

W5.15 16:00–17:30 ***Linearizing the mode transition in LPFG sensors with metal and dielectric thin films***

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Long Period Fiber Gratings (LPFGs) are a versatile sensing platform due to their ability to couple core and cladding modes through periodic refractive index modulation, making them sensitive to changes in the surrounding refractive index (SRI). Sensitivity can be enhanced via mechanisms like dispersion turning points and mode transitions. However, their performance is non-linear. This work explores the relationship between mode transitions and lossy mode resonances (LMRs), both occurring within the same thin-film thickness range. By depositing a gold layer followed by a TiO_2 layer, we achieved highly sensitive, linear performance and minimized the attenuation band's bandwidth. Two LPFGs with different modulation indices were fabricated, and their spectral response to varying TiO_2 thickness was monitored. Results showed LPFGs could achieve a sensitivity of 9 nm/nm, similar to LMR sensors, with a linear evolution as a function of thickness and potential for bandwidth improvement. This could enhance LPFGs' applicability in environmental and biosensing, with room for further optimization.

W5.16 16:00–17:30 ***Force feedback using fiber Bragg gratings embedded in a suction cup***

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Continuous monitoring of grasp quality is critical in various industrial processes. This study explores the use of Fiber Bragg Gratings (FBGs) for force monitoring in a silicone suction cup, a common tool in pick-and-place and packaging operations. A newly designed silicone suction cup with embedded FBGs was tested to analyze its response to different parameters, primarily vacuum level and weight. The embedded sensors enable accurate measurement of lifted weights for a given vacuum level and vice versa. The sensorized suction cup demonstrates linear behavior concerning vacuum level. Pick and place operation has been simulated, and the device can detect parts, optimize vacuum usage, and react to external disturbances, maintaining a secure grasping. This innovation provides valuable insights into industrial processes, prevents part slippage, minimizes energy consumption and it could enhance the capabilities of simpler grippers for more complex assembly tasks.

W5.17 16:00–17:30 ***Pipeline intrusion events recognition method based on AWTFE image enhancement for DAS***

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In this paper, we propose an image enhancement method for reliable threat event recognition in distributed acoustic sensing systems. The method significantly enhances image features of threat events, achieving classification accuracies of 96.69%, 97.65%, and 99.96% for intrusion event recognition using 2D-CNN, ResNet18, and Vgg13_BN networks, respectively

W5.18 16:00–17:30 ***Full spectral Interrogation of π-phase-shifted TFBG based refractive index sensor using convolutional neural network***

Ziqi Liu[a], Chang Liu[a], Xiaoliang Cao[a], Zhaohui Li[a,b], Zhengyong Liu*[a,b]; [a]School of Electronics and Information Technology, Sun Yat-sen University, Guangzhou 510006, China; [b]Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Zhuhai 519082, China.*liuzhengy@mail.sysu.edu.cn

In this paper, a refractive index (RI) sensor based on π-phase-shifted titled fiber Bragg grating (π-PSTFBG) is proposed to solve the problem that the demodulation features of one-dimensional spectrum are less, and the feature richness is improved from the perspective of the spectrum itself, which is a good method to improve the generalization ability of the deep learning demodulation model. For verification, the proposed dense connected convolutional neural network (D-CNN) is used, which has excellent demodulation performance especially for the seen spectral samples, and is of great significance for the detection of biological and chemical parameters in the marine environment.

W5.19 16:00–17:30 ***Hollow-core fiber cavity-enhanced stimulated Raman gain spectroscopy for trace hydrogen detection***

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We demonstrate a hydrogen sensor based on hollow-core fiber cavity-enhanced stimulated Raman gain spectroscopy. Using an 8-cm-long hollow-core fiber cavity with finesse of ~ 300, hydrogen detection with a limit of detection of 62 ppm is achieved with 1 s lock-in time constant.

W5.20 16:00–17:30 ***Mechanical measurements in filament-wound composite cylinders by optical fiber specklegram sensor***

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Filament wound (FW) composite structures are appealing alternatives to conventional materials due to their improved strength, reduced weight, and optical fiber integration capability. However, current (quasi) distributed sensing approaches rely on intricate and expensive interrogation systems. Therefore, this paper proposes a fiber specklegram sensor to detect radial stress/strain in an FW cylinder. The probe comprises a laser-illuminated multimode waveguide attached to the composite sample wall. The fiber outputs a characteristic speckle pattern that varies with the applied mechanical stimuli' magnitude and location. Thus, we compute the correlation coefficient to quantify the specklegram changes in response to radial efforts. Furthermore, choosing the reference speckle image discriminates force orientation and position along the cylinder's extent through a single fiber/wavelength scheme. Such promising results motivate further development of a smart composite structure with integrated strain sensing ability.

W5.21 16:00–17:30 ***Optical fiber-based sensing platform with integrated biodegradable agar-structured transducer***

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Emerging applications in biochemical and biomedical sensing demand degradable and biocompatible optical fibers to replace the widespread glass and plastic waveguides. Agar prevails amongst soft optical materials as a renewable, transparent, edible, and thermoreversible gel, supporting the manufacture of lenses and waveguides. Thus, this paper proposes an agar-glycerol-made structured optical fiber integrated into a slab substrate for mechanical and chemical sensing. A 3D-printed mold creates air holes around the solid core, leading to optical losses of 2.42 dB/cm at 633 nm. Moreover, we investigated the sensor response to transverse forces by assessing the output light through specklegram analysis, yielding a practical resolution of 0.04 N. Ultimately, exposing the transducer to surrounding fluids reveals characteristic speckle field changes due to the agar syneresis and swelling effects. The preliminary results encourage further applications of the integrated optical fiber as a biocompatible and disposable sensing platform for growth media and microfluidics setups.

W5.22 16:00–17:30 ***High-resolution interrogation of FBG-based inclination sensor with microwave photonic filtering technique***

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This paper focuses on a multi-point inclination sensing system composed of fiber Bragg grating (FBG)-based inclination sensors. A high-resolution demodulation method is introduced, employing the microwave photonic filtering technique. The system's frequency response is processed through a frequency-to-time domain transformation, which effectively maps the FBG wavelength into the time domain. This method enables the measurement of the time interval between the two FBGs, facilitating high-precision demodulation of both the tilt angle and direction. Moreover, the system effectively eliminates the influence of temperature fluctuations on inclination measurements. Experimental results demonstrate that the system achieves an inclination measurement sensitivity of 17.806 ps/° within a range of ±10°, with a resolution of 0.023°.

W5.23 16:00–17:30 ***All-optical direct strain sensor based on multimode fiber and optical computing***

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Most optical fiber sensing systems require post-processing to obtain measurement information, resulting in computational burden and slow measurement speed. We propose a novel all-optical strain sensor with resolution of 0.74 με by directly reading photodetector output with multimode fiber speckle sensing and diffractive optical computing technologies.

W5.24 16:00–17:30 ***Silicon photonic interrogator for Brillouin optical time-domain analysis***

Zhicheng Jin[a], Jiageng Chen[a,*], Yang Zhang[a], Mengying Ru[a], Zhengwen Li[a], Hanzhao Li[b], Keke Hu[b], Xuhui Yu[b], Zuyuan He[a]; [a]State Key Laboratory of Advanced Optical Communication System and Networks, Shanghai Jiao Tong University, Shanghai 200240, China; [b]Ningbo AllianStream Photonics Technology Co., Ltd., Ningbo 315524, China.*jiagengchen@sjtu.edu.cn

We present the first integrated interrogator for Brillouin optical time-domain analysis (BOTDA) based on the silicon-on-insulator (SOI) platform. The integrated interrogator comprises four functional sections: the light source selection and distribution section, the probe light generation section, the pump light generation section, and the photo detection section. In the demo experiment using single-pulse configuration, we achieve a 0.28 MHz Brillouin frequency shift (BFS) uncertainty over 25 km of sensing fiber, with 5 m spatial resolution and 1000 times of averaging.

W5.25 16:00–17:30 ***High-SNR integrated Φ-OTDR based on injection locking laser and frequency diversity***

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An integrated phase-sensitive optical time domain reflectometer (Φ-OTDR) based on injection locking laser and frequency diversity is reported with high signal to noise ratio (SNR). The integrated Φ-OTDR utilizes injection locking laser for frequency shift and semiconductor optical amplifier (SOA) for chopping. By employing 3-order frequency diversity, a high SNR of 57 dB and an excellent strain resolution as high as 0.835 pε/√Hz at a 10 m gauge length can be obtained.

W5.26 16:00–17:30 ***Research on temperature characteristics of open cavity fiber optic sensing structure***

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An open cavity Mach Zehnder interferometer is put forward. By relying on femtosecond laser microfabrication technology and introducing temperature sensitive material, high-sensitivity measurement of ocean temperature is achieved, with a resolution of up to 0.0002°C.

W5.27 16:00–17:30 ***Nano-g resolution optical fiber MEMS accelerometer with symmetric push-pull spring structure***

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A fiber-optic MEMS accelerometer based on a symmetric push-pull spring structure made by micromachining on a silicon substrate is presented, which combines the advantages of low noise, high sensitivity, and large operation bandwidth compared with existing fiber-optic MEMS accelerometers. Experimental results show that the accelerometer achieves a sensitivity of 47.1 dB re rad/g (226.2 rad/g) and a noise floor as low as 10 ng/Hz1/2 indicating that it has a nano-g resolution.

W5.28 16:00–17:30 ***Detecting single ultra fine particles with fiber-tip sensors***

Hasan Yalcinoglu, Arthur L. Hendriks, Mildred S. Cano-Velázquez, René P.J. van Veldhoven, Andrea Fiore; Eindhoven University of Technology, Department of Applied Physics and Science Education, De Groene Loper 19, 5612 AP Eindhoven/Netherlands

In this study, the next generation of novel nanophotonic fiber-tip sensors based on photonic crystal cavities were realized. Building up on the findings from the previous studies from TU/e, optimization algorithms were implemented to achieve tiny a mode volume, a high quality factor, and a large reflection modulation from the fiber, with a goal of reducing the size limit of detection for single nanoparticles. These nanophotonic cavities on fiber-tips can be used for the detection of individual nanoscale objects or even large single molecules.

W5.29 16:00–17:30 ***Chirped-pulse DAS as a seismic surface wave monitoring tool along trackside dark fibers: application in the analysis of superstructure features***

Javier Preciado-Garbayo[a,*], Jorge Canudo[a], Miguel Gonzalez-Herraez[b], Hugo F. Martins[c], Beatriz Gaite-Castrillo[d], Jose Benito Bravo-Monge[d], Irene de Maria[e], Miguel Rodriguez-Plaza[e]; [a]Aragon Photonics Labs. C/ Prado 5, 50009 Zaragoza, Spain; [b]University of Alcala de Henares, 28805 Madrid, Spain; [c]Instituto de Optica, CSIC. C/ Serrano 121, 28006 Madrid, Spain; [d]Instituto Geografico Nacional. C/ General Fernandez de Ibero 3, 28003 Madrid, Spain; [e]Administrador de Infraestructuras Ferroviarias (ADIF). C/ Titan 4-6. 28045 Madrid, Spain.*j.preciado@aragonphotonics.com

Distributed Acoustic Sensing (DAS) is a fiber-optic sensing technology that transforms optical fiber telecommunication cables into arrays of thousands of broadband strain meters. Chirped-pulse DAS has demonstrated enhanced performance, offering an optimal balance between range and sensitivity, particularly at low frequencies. In seismology, these capabilities enable the high-resolution detection of seismic waves generated by events such as local and teleseismic earthquakes, as well as micro-seismic vibrations caused by trains or vehicles, which is the focus of this work.

The DAS data collected from trackside fibers offer substantial insights into terrain features and the condition of railroad superstructures. These findings underscore the potential of DAS systems for monitoring seismic surface waves and assessing superstructure conditions using preinstalled fibers. Furthermore, tracking the evolution of this information over time can provide valuable insights for infrastructure owners, especially in critical applications like high-speed railway systems. Additionally, the local dispersion relation for surface waves can reveal further details about the superstructure.

W5.30 16:00–17:30 ***ZnO nanoparticles doped optical fibers for radioluminescence sensors***

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High-energy radiation has been used in many industrial and scientific applications. However, it usually has a negative impact on human health. Special attention has been paid to visualization and monitoring of harmful radiation to quantify the radiation intensity and prevent the undesired exposition. Radioluminescence optical fibers represent a special category of components allowing the construction of distributed radioluminescence sensors. We successfully implemented Eu-doped ZnO nanoparticles into optical fiber to prepare radioluminescence optical fiber. The concentration of ZnO was 0.85 at.% and the refractive index of the core was 1.459. The background optical losses reached the values of 10.74, 1.87, and 0.83 dB⋖m-1 recorded at 450, 550 and 850 nm, respectively. We proved that the fiber exhibits luminescence properties under UV excitation showing broad luminescence band in the 350 to 550 nm range and two well pronounced luminescence bands of Eu3+ ions in the 560 and 640 nm range. Fiber can be used as a sensing element in distributed radioluminescence sensors for monitoring of high-energy radiation.

W5.31 16:00–17:30 ***Field trial of railway track defect detection with DAS***

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This paper presents a field trial on a heavy-haul railway in Zhangjiakou in China using DAS and communication optical fibers. The fibers, located in cable trenches along the railway, were used to detect and classify four types of track health states which includes three typical defects. This approach utilizes existing communication fibers, requiring no additional sensor deployment. It enables long-distance, all-weather monitoring of railway track health. The results confirm the system's ability for real-time defect detection and field application suitability.

W5.32 16:00–17:30 ***A hybrid demodulation algorithm for high-sensitivity and wide-range quasi-distributed fiber optic sensing***

Rongrong Niu, Qingwen Liu*, and Zuyuan He; State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong University, Shanghai 200240, China

A joint algorithm of preliminary phase determination-phase adaptive adjustment (PPD-PAA) is proposed in an double-sideband optical frequency domain reflectometry (DSB-OFDR) for high sensitivity and wide-range vibration measurement along the sensing fiber. This algorithm combines the advantages of the newly introduced Doppler frequency method and the traditional phase-based method, enhancing the measurement sensitivity by 15 dB over an almost unlimited measurement range.

W5.33 16:00–17:30 ***Applying draw tower FBGs to characterize fiber drawing processes***

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Fiber Bragg gratings (FBGs) inscribed during the fiber drawing (DTG) have an increased importance in the sensing market because of their outstanding properties, especially robustness, multiplex ability and efficient production of higher counts. A sensing system to characterize and optimize the DTG production process was developed and tested successfully. It uses the produced DTG itself as sensors to monitor drawing processes. The dynamic of drawing force variations and influences of different curing techniques at coating materials can be examined excellently with high time resolution. Analyzing the data on the variation of inscribed DTG Bragg wavelengths leads to optimization possibilities to

decrease these variations. Temperature increases in the coating curing lamp were measured for different lamp powers. Because of a short throughput-time in the draw tower, a fast and multipeak interrogation unit was developed to get an appropriate dynamic time resolved measurement.

W5.34 16:00–17:30 ***Large-area hole-sphere nanogap platform for high-sensitivity, low deviation SERS analysis and its applications***

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The hole-sphere nanogap (HSNG) platform offers a scalable and highly uniform Surface-Enhanced Raman Scattering (SERS) substrate, addressing challenges in signal enhancement and reproducibility. Fabricated through sequential thin film deposition, heat treatment, and wet etching, the HSNG structure achieves signal uniformity below 10% across a 6-inch wafer and an enhancement factor exceeding 10^8. By precisely tuning nanoparticle size and nanogap distance, the platform optimizes localized surface plasmon resonance (LSPR) for trace-level detection. HSNG demonstrated its versatility in detecting arsenic compounds in water at concentrations down to 1 ppm, explosive vapors such as TNT at atmosphere pressure, and contaminants like melamine and pesticides in food matrices. Its high sensitivity, reproducibility, and scalability make HSNG a promising candidate for field-deployable sensing systems in environmental, security, and food safety applications.

W5.35 16:00–17:30 ***Ultra-wideband wavelength-swept laser with a 440 nm scanning range using four SOAs***

Min Su Kim[a,*], Soyeon Ahn[a], Ji Su Kim[a], Byeong Kwon Choi[b], Sung Yoon Cho[a], Jaehyun Yoo[a], Minjun Kim[c], and Min Yong Jeon[a,c]; [a]Department of Physics, College of National Sciences, Chungnam National University, Daejeon, Republic of Korea 34134; [b]Siemens Electronic Design Automation (Korea) LLC, Seongnamsi, Gyeonggi-do, 13524, Republic of Korea; [c]Institute of Quantum System, Chungnam National University, Daejeon, Republic of Korea 34134

Broadband wavelength-swept lasers (WSLs) have many advantages in multi-point sensing and dynamic sensing in fiber optic sensors. In this paper, we report the implementation of an ultra-wideband WSL source with a 440 nm scanning range. It is composed of a polygonal scanning mirror-based wavelength tunable filter (PSM-TF) and four semiconductor optical amplifiers (SOAs). It consists of two independent gain media and PSM-TF, each gain media is configured in a Mach- Zehnder interferometer, and the central wavelengths are approximately 1250 nm and 1450 nm, respectively. The WSL achieved a 10-dB spectral bandwidth of 440.8 nm in the spectral domain and a temporal output duration of 323.8 μs at a scanning frequency of 2.338 kHz. The conversion ratio between the spectral and time domains over the scanning range was determined to be 1.361 nm/μs. The duty cycle was measured to be 75.7% from the oscilloscope trace, and the free spectral range in the spectral domain was calculated to be approximately 582.3 nm.

W5.36 16:00–17:30 ***Two-dimensional acoustic source localization algorithm based on physics-informed neural network in distributed acoustic sensing***

Dongyang Zhao, Yangyang Wan*, Jiageng Chen, and Zuyuan He; State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong University, Shanghai 200240, China.*YangyangWan@sjtu.edu.cn

This paper proposes a Physics-Informed Neural Network (PINN)-based algorithm for acoustic source localization in Distributed Acoustic Sensing (DAS) systems, achieving an average localization error of 6.4 cm within a 5×5 m area. Compared to conventional data-driven neural networks, the method demonstrates superior generalization and robustness in high-noise environments. By integrating physical models into the loss function, the PINN improves localization accuracy by 4.9% and effectively handles unseen noise patterns.

W5.37 16:00–17:30 ***Embedding fiber-optic sensors in DEB-LB processes for structural monitoring***

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The development of Fiber Bragg Grating-type fiber optic sensors designed to monitor a novel High Entropy Super Alloys aimed to resist the high temperatures that a structure in an industrial environment of a steel mill must withstand is detailed. This paper outlines the manufacturing process of these Fiber Bragg Grating sensors, coating, thermal and mechanical characterization, embedding on new High Entropy Super Alloys material procedure for integrating these sensors into the metallic structure by Direct Energy Deposition technique, laser cladding, and their validation over the first three weeks of operation in the steel mill furnace.

W5.38 16:00–17:30 ***Astigmatism-controlled beam shaping for high-quality fibre Bragg grating inscription using femtosecond laser***

Lukman Kamarudin[1], Yuehui Ma[1,2], Jiaxuan Li[1,3], Bing Sun[4], Kaiming Zhou[1]*; [1]Aston Institute of Photonic Technologies, Aston University, Aston Triangle, Birmingham B4 7ET, United Kingdom; [2]The Key Laboratory of Specialty Fiber Optics and Optical Access Networks, Joint International Research Laboratory of Specialty Fiber Optics and Advanced Communication, Shanghai University 200444, China; [3]School of Information Science and Engineering, The Key Laboratory for Special Fiber and Fiber Sensor of Hebei Province, Yanshan University, Qinhuangdao 066004, China; [4]Advanced Photonic Technology Lab, College of Electronic and Optical Engineering & College of Flexible Electronics (Future Technology), Nanjing University of Posts and Telecommunications, Nanjing 210023, China; *k.zhou@aston.ac.uk

We present an astigmatism-controlled beam-shaping technique for femtosecond laser inscription of FBGs, optimizing beam profiles using a cylindrical lens to mitigate focal distortion and enhance grating quality. This method improves reflectivity, reduces insertion losses, and expands grating dimensions, offering a scalable solution for advanced optical communication and sensing

W5.39 16:00–17:30 ***Wide-spectrum erbium-doped fiber ring laser induced by deexcitation at high pump power***

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In this paper, a wide-spectrum erbium-doped fiber ring laser (EDFRL) based on the phenomenon of deexcitation is investigated. Experimental results indicate that, at a pump wavelength of 1455 nm, the stimulated Raman scattering effect induces deexcitation within the laser. This leads to a transition from the excited state to the non-excited state, ultimately resulting in a stable wide-spectrum output. The remaining pump power could be used for optical fiber amplifier to enhance the output power. Combining deexcitation with pump light amplification offers a novel approach for designing high-performance wide-spectrum fiber laser, which shows significant potential for Sagnac-type interferometric optical fiber sensing system. Additionally, the output spectrum aligns with ITU-T standard wavelengths. This characteristic renders the EDFRL highly suitable for a diverse range of practical applications.

W5.40 16:00–17:30 ***Smart tape for monitoring the automated tape layering process using all-grating fiber sensors***

M. C. Nespereira[a], Rubén Ruiz Lombera[a], Tania Grandal González[a], Beatriz Simoes Pereira Gomes[a], Ibon Aranberri Askargorta[b], Aratz Genuab, Asier M. Salaberria[b]; [a]AIMEN Technological Center, Polígono Industrial de Cataboi, SUR-PPI-2 (Sector 2), Parcela 3, 36418 O Porriño, Pontevedra, Spain; [b]CIDETEC Technological Center, Parque Científico y Tecnológico de Gipuzkoa, Paseo Miramón, 196, 20014, Donostia/San Sebastián (Spain)

It has been developed a procedure for monitoring an automated tape layering (ATL) with an in-situ consolidation system using fiber optic sensor (FOS). It is used a special type of optical fiber, All

Grating Fiber (AGF), that consists of an optical fiber densely engraved with Fiber Bragg Gratings (FBGs). The optical fiber was previously embedded in composite Carbon Fiber (CF) tapes, pre-impregnated with resin. The AGF sensor monitors the ATL process sensing the temperature of the tape deposition and the force/pressure of the consolidation roller. This will allow the optimization of the ATL process window to obtain a defect-free laminate consolidation.

W5.41 16:00–17:30 ***Monitoring the effects of planar constraint on strain accumulation during epoxy resin curing process using fibre Bragg gratings***

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The control and monitoring of epoxy resins' curing process is crucial for ensuring product quality and minimizing production times. The curing of epoxy resin involves changes in temperature, strain, and refractive index. Strain accumulates during the curing process as a result of several factors, including changes in temperature and resin cross-linking. We report an experimental investigation on strain accumulation during the epoxy curing process using fibre Bragg gratings sensors. We studied strain accumulation in resin samples that were either unconstrained or constrained in a plane, similar to how resin hardens in a mould. The results show that strain primarily accumulates during the cooling of the cured epoxy. The sample with a planar constraint develops anisotropic strain, which causes changes in the spectrum profile of the fibre Bragg gratings.

W5.42 16:00–17:30 ***Remote structural health monitoring employing OFDR via optical fiber communication networks***

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In the field of structural health monitoring with optical fiber sensing, installing instrumentation close to the structure is often challenging. By connecting the structure to the measuring device with a transmission optical fiber (this section not subject to measurement), advantages such as indoor installation of the measuring device and shared monitoring of multiple structures can be achieved. However, in such cases, part of the measurement range is consumed by the length of the transmission fiber, significantly limiting the effective measurement range. In this paper, we propose a novel optical frequency domain reflectometry (OFDR) configuration that bypasses the transmission fiber. We demonstrate remote strain measurements on a 1-km section of the fiber under test, located 25 km away from the OFDR system. Strain measurements of up to 1000 με with a spatial resolution of 10 cm were successfully achieved.

W5.43 16:00–17:30 ***Photo-bleaching effect of a 980 nm light source on radiation-induced attenuation in pure silica core fibers***

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We investigated the photo-bleaching effect of a 980 nm light source on the radiation-induced attenuation (RIA) in pure-silica core fibers, specifically for the development of distributed sensors in radiation-rich environments. Through gamma-ray irradiation experiments, we analyzed the influence of photo-bleaching on RIA within the 1400–1600 nm wavelength range and examined the effects on the RIA spectra due to changes in the power of the bleaching light source.

W5.44 16:00–17:30 ***Multi-gas analysis using dual-comb driven nanomaterial functionalized micro fiber Bragg grating array***

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Detecting gas molecules is a fundamental yet remarkable capability in nature. It involves both the qualitative identification of gas species and the quantitative measurement of their concentrations. In this study, we utilized an integrated Kerr soliton microcomb to drive a network of micro-fiber Bragg grating (micro-FBG) gas detectors on a chip. Each micro-FBG was coated with a distinct nanomaterial tailored to respond to a specific gas. The system successfully identified 12 different gas components and achieved a minimum detection limit of 45 parts per billion.

W5.45 16:00–17:30 ***A machine learning approach for designing surface plasmon resonance PCF based sensors***

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This study explores the application of machine learning algorithms to optimize the geometry of the plasmonic layer in a surface plasmon resonance photonic crystal fiber sensor. By leveraging the simplicity of linear regression (LR) alongside the advanced predictive capabilities of the gradient boosted regression (GBR) algorithm, the proposed approach enables accurate prediction and optimization of the plasmonic layer's configuration to achieve a desired spectral response. The integration of LR and GBR with computational simulations yielded impressive results, with an R^2 exceeding 0.97 across all analyzed variables. Moreover, the predictive accuracy demonstrated a remarkably low margin of error, $\epsilon < 10\text{-}15$. This combination of methods provides a robust and efficient pathway for optimizing sensor design, ensuring enhanced performance and reliability in practical applications.

W5.46 16:00–17:30 ***Hydrogen sensor based on hollow-core fiber photothermal spectroscopy***

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We report an optical fiber hydrogen sensor utilizing the photothermal spectroscopy within a hollow-core fiber, specifically targeting the 2121.8-nm quadrupole absorption line of hydrogen. Experiments demonstrate that the optical fiber sensor can detect hydrogen gas at the concentration level of 77 ppm when the lock-in time constant is 1 second. The optimal integration time is determined to be around 1867 seconds corresponding to a noise equivalent concentration of 7.2-ppm hydrogen. Importantly, we discover an intriguing phenomenon that, at higher concentrations, photothermal signal decreases with the increase of hydrogen concentration. Thermal dynamics analysis and numerical simulations indicate that the phenomenon arises from the combined effects of molecular collisional relaxation, thermal conduction process and thermo-optic effects of gas materials inside the hollow-core optical fiber.

W5.47 16:00–17:30 ***All-fiber content-addressable memory (CAM) for in-sensor computing***

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The in-sensor computing based on fiber can transmit near-light-speed information, skip photoelectric conversion, shorten data storage and reading delay, and quickly respond to massive data for intelligent optical sensor networks. Content Addressable Memory (CAM) is capable of screening the useful data sensed in intelligent photonic perception networks and filtering out redundant data. Herein, we propose an all-optical CAM based on fiber and Ge2Sb2Te5 (GST), the device structure is simple and easy to manufacture. The maximum average power density for an individual CAM cell is 23.64 nW/μm2 and requires no continuous power input to maintain the switching states, which is also naturally advantageous given the low-power density and the long intervals between entry updates in modern optical packet switching systems.

W5.48 16:00–17:30 ***LSPR-based fibre optic Sensor fabricated by laser annealing of thin gold films***

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A fibre optic sensor based on localized surface plasmon resonance (LSPR) is fabricated by transforming a thin gold film deposited on the sensor tip into gold nanoparticles (AuNPs) using the laser annealing technique. The reflected spectra of the sensor exhibit a strong LSPR peak between 600 and 650 nm. The sensor is capable of detecting refractive index (RI) changes within the tested range of 1.3 to 1.395. As the RI increases, clear wavelength shifts in the peak wavelength are observed. The sensor responds linearly to RI variations, achieving a sensitivity of -215.8 nm/RIU. SEM analysis confirms the successful formation of AuNPs, which are essential for the sensor's high sensitivity and consistent performance. The fabricated sensor is cost-effective, easy to fabricate, and suitable for biochemical applications.

W5.49 16:00–17:30 ***Microdisplacement sensor based on a processed optical fiber by an ultrafast laser-assisted etching method***

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In this work, a fabrication technique for microchannel-based reflectors used as an optical fiber sensor is demonstrated by using a processed optical fiber by an ultrafast laser-assisted etching method. This microdisplacement sensor was experimentally demonstrated to have an outstanding resolution of 5.9 rad/μm in the measurement range from 0 to 80 microns, by using the fast Fourier transform (FFT) measuring method.

W5.50 16:00–17:30 ***Laser-activated optofluidic microrod hydrogen sensor with single ppm sensitivity and 5 orders of magnitude detection range***

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Functionalized whispering-gallery-mode (WGM) optofluidic microcavities offer a promising platform for gas detection. However, achieving high-performance hydrogen detection with a large dynamic range remains challenging. Traditional microcavity materials are often insensitive to hydrogen adsorption, and there is a trade-off concerning the intracavity Q factor: a high Q factor enables high resolution but limits the measurable range. In this study, we propose an H-Pt/WO3 inner-deposited optofluidic microrod sensor and employ laser-triggered technology for on-line hydrogen detection. By leveraging the thermal conduction effect, our design overcomes the trade-off between high precision and a large range, demonstrating ppm sensitivity and a detection range spanning 5 orders of magnitude.

W5.51 16:00–17:30 ***FEM simulation for the design of a smart washer-type sensor with FBG for use in metro-railway platform door security systems***

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These article presents a new approach to improving the safety and efficiency of Platform Door Security Systems in transportation networks using instrumented washers equipped with FBG sensors. The methodology included finite element analysis to identify regions of maximum deformation in customized washers, ensuring the precise placement of the FBG sensors. These “smart washers” proved highly effective in detecting load variations, such as the additional weight of objects or individuals, by linking mechanical deformation to changes in the Bragg wavelength. This innovative solution showed excellent sensitivity and accuracy, highlighting its potential for real-time monitoring of mechanical stresses and enhancing safety by reducing risks.

W5.52 16:00–17:30 ***Monitoring and early-warning technique for expressway substructure defect detection based on ultra-weak FBG array sensors***

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The aging of expressway pavements poses a significant threat to safety and functionality, particularly exacerbated by extreme climate events. Real-time, non-intrusive detection technologies are essential for identifying concealed defects before accidents occur. In this work, an Ultra-Weak Fiber Bragg Grating (UWFBG) array system is used to detect road defects without disrupting traffic. Field tests for voids beneath the pavement show that the UWFBG system can accurately locate subgrade voids using intensity-based waveforms. Frequency analysis provides additional details on concealed defects. This method supplies a transformative solution to early warning of subsurface issues, significantly improving expressway safety and intelligent management level for the ultra-high-throughput traffic network.

W5.53 16:00–17:30 ***End-to-end deep learning framework for coarsely sampled TFBG-SPR spectrum demodulation***

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Tilted Fiber Bragg Grating (TFBG) sensors integrated with Surface Plasmon Resonance (SPR) offer high sensitivity for various sensing applications. However, analyzing their complex spectra remains challenging. This work introduces a novel deep-learning framework for real-time demodulation of coarsely sampled TFBG-SPR spectra, achieving refractive index resolutions on the magnitude of -5 RIU. The framework exhibits cross-fiber adaptability, enabling deployment in diverse sensing environments. A compact, low-cost data acquisition system demonstrates the framework's industrial viability. Experimental results validate its robustness and accuracy even under noisy and low-resolution conditions, paving the way for cost-effective and portable TFBG-SPR sensing solutions.

W5.54 16:00–17:30 ***Sparking fiber random laser for wavelength scanning***

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A fiber random laser capable of stochastic wavelength scanning and definite control is proposed, providing a good light source for high-speed wavelength sampling and spectral super-resolution spectroscopy applications. It holds significant potential in fields such as optical fiber sensing and other applications.

W5.55 16:00–17:30 ***Phase-sensitive common-path dual frequency comb spectroscopy***

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Common-path dual comb spectroscopy using a single electro-optic modulator has been reported as a flexible, simple and low-cost symmetric dual comb configuration capable of measuring fine spectral signatures in the MHz regime with an extraordinarily high stability over acquisition times of seconds. However, the main drawback of symmetric dual comb configurations is that only the amplitude spectral response of the sample is obtained, losing any information from the phase spectral profile. In this work, we formulate and demonstrate, for the first time to our knowledge, an algorithm capable of extracting spectral phase information from a symmetric dual comb configuration. A phase reconstruction strategy based on the analysis of the spectral phase profile of high order Nyquist zones is performed. Our proposed algorithm is validated by extracting the transmission and phase profiles of a lossy fiber-based ring resonator.

W5.56 16:00–17:30 ***Self-assembled hierarchical nanostructures: towards advanced SERS optrodes***

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We report a low-cost method to controllably fabricate surface-enhanced Raman scattering (SERS) active substrates with high density of hot spots. The SERS substrate is composed of a regular pattern of hierarchical structures of plasmonic assisted nanospheres (HSNs). The HSNs exploit the architecture of self-assembled close-packed arrays (CPA) of nanospheres, with hexagonal symmetry. An additional layer of upper nanospheres is incorporated to generate another plot of intense hotspots situated within the nanogaps between adjacent nanospheres. Computational analyses were conducted to delineate the design principles and elucidate factors influencing SERS performance. HSNs have been fabricated and morphologically characterized. Empirical assessment of the SERS response reveals that HSNs can serve as economically viable SERS substrates exhibiting enhanced performance compared to the more straightforward single-layer CPA arrangements. The proposed approach would represent a general strategy for the fabrication of periodic 3D hierarchical SERS nanostructures with superior performances for Lab on Fiber SERS optrodes.

W5.57 16:00–17:30 ***Polarization-mode-phase-difference photothermal gas sensing with an optical microfiber coupler***

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We report an evanescent-wave photothermal interferometry gas sensor by measuring the phase difference between two polarization modes in a single-mode bi-conical tapered microfiber coupler. With a 2-cm-long, wavelength-scale-diameter microfiber coupler, the noise-reduction capability to external perturbations is significantly improved, resulting in a detection limit of 28 ppb for acetylene with a 1-s lock-in time constant.

W5.58 16:00–17:30 ***Data processing optimization for TFBG spectral discretization and sensor coding***

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Tilted fiber Bragg gratings (TFBGs) offer several advantages for sensing applications; however, their interrogation entails complex spectral analysis with expensive instrumentation. As an alternative to conventional methods for TFBG signal processing, recently, it was proposed to discretize the TFBG spectrum to correlate a target measurand with a set of binary codes (bits) of "0" and "1". In this work, we report on the optimization of such discretization process. We have generated such bits by discretizing different TFBG spectral ranges; the minimum number of bits needed to distinguish refractive index changes has been analyzed as well. It is demonstrated that the analysis of a narrow (~ 6 nm) spectral range of a TFBG immersed in different isopropyl alcohol (IPA) water mixtures can be sufficient to generate sets of bits that can be correlated with the mixtures.

W5.59 16:00–17:30 ***Plastic optical fiber alkane gas sensor with polyisoprene cladding and carbon black-doped polyisoprene layers***

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A two-layer plastic optical fiber (POF) alkane sensor was developed to improve sensitivity for detecting alkane gases. The sensor utilizes a lower polyisoprene (PIP) cladding layer and an upper carbon black-doped PIP (CB PIP) layer. In the presence of alkanes, the cladding swells, reducing its refractive index and shifting the light propagation mode from leaky to waveguide, thereby increasing the transmitted light intensity. The CB PIP layer absorbs leaked light in the leaky mode, further enhancing sensitivity. This design achieved over 10 times higher sensitivity for alkane detection at concentrations above 7 mmol/L compared to a single-layer POF sensor.

W5.60 16:00–17:30 ***All-fiber counter-propagating all-normal-dispersion (CANDi) laser for coherently averaged dual-comb spectroscopy***

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This study introduces an all-fiber counter-propagating all-normal-dispersion (CANDi) laser. By using polarization-maintaining fibers and a fiber polarization beam splitter, a compact and stable all-fiber structure is constructed, replacing traditional free-space components to reduce cavity loss and noise. The laser not only retains the advantages of conventional CANDi lasers but also achieves a new stable bi-directional dual-wavelength locking state, demonstrating excellent self-starting performance in both single-wavelength and dual-wavelength modes. In dual-comb spectroscopy, it successfully measured the transmission spectrum of a high-Q microcavity at the 1070 nm band, showing great potential in high-sensitivity spectroscopic sensing. This all-fiber CANDi laser provides a simple, fast, and high-bandwidth solution for high-resolution dual-comb spectroscopy without active stabilization, revealing broad application prospects in fiber-optic sensing.

W5.61 16:00–17:30 ***A hybrid structural health monitoring system based on Lamb waves and distributed optical fiber sensors***

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This study proposes a hybrid structural health monitoring (SHM) system, integrating a high-resolution distributed optical fiber sensor and an active ultrasonic guided wave-based monitoring technique. The optical fiber sensor measures the strain induced by external loads, while the ultrasound guided waves provide damage identification and detection capabilities. Combining the two techniques, the reliability of SHM systems in complex monitoring scenarios can be largely enhanced

W5.62 16:00–17:30 ***Ultra-high stability chip-scale optical gyroscope***

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Broadband source-driven resonant optical gyroscopes (ROGs) based on whispering gallery mode (WGM) microcavities provide a highly stable solution for practical applications of chip-scale gyroscopes. This study presents a ROG employing a 28.5-mm WGM microcavity as the core sensitive element, achieving long-term stability of 0.5°/h over a 10-hour test period. Additionally, the gyroscope achieves a scale factor nonlinearity of less than 100 ppm over a test range of ±500°/s. The achievement of these results represents a significant advancement in the development of high-performance and practical chip-scale optical gyroscopes.

W5.63 16:00–17:30 ***High-resolution mid-infrared dual electro-optic comb spectroscopy based on spectral interleaving***

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We propose a novel mid-infrared dual electro-optic comb spectroscopy method with high spectral resolution based on spectral interleaving. It offers a frequency resolution of 100 MHz, providing a bandwidth of 486 GHz.

W5.64 16:00–17:30 ***New sensing solutions based on Fibre Bragg Gratings for engineering applications***

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The article introduces new sensing solutions utilising Fibre Bragg Gratings (FBGs) for civil engineering and geotechnical applications. The first, named EpsilonPeak, is an innovative FBG design developed to measure non-uniform strain fields, such as those found in textile composites, cracked concrete, or steel after reaching the yield point (plastic strains). This sensor is resistant to shearing strains, significantly extending its measurement range compared to conventional FBGs. The second solution is a hybrid sensor that combines the benefits of spot FBGs with distributed fibre optic sensing (DFOS). The sensor's composite, monolithic core contains two optical fibres: one with a predefined FBG array for automated readings using relatively inexpensive interrogators, and the other, a standard telecom fibre, providing data periodically but continuously along its length. The article summarises the design and potential applications of both sensing solutions.

W5.65 16:00–17:30 ***Avalanche photodiode integrated silicon photonics MIOC for interferometric fiber optic gyroscope***

Meng-Hsuan Tsai, Jen-Shu Lo, Ting-Hsuan Kuo, Wei-Xuan Chen, and Yung-Jr Hung*; Dept. of Photonics, National Sun Yat-sen University, No. 70, Lienhai Rd., Kaohsiung, Taiwan.*yungjr@mail.nsysu.edu.tw

By integrating III-V avalanche photodiode atop output grating coupler of a silicon photonics MIOC, we demonstrate an improved scale factor at low-to-intermediate input light intensity (< 0 dBm) in an interferometric fiber optic gyroscope. However, such APD-integrated IFOG exhibits a slightly higher angle random walk of ~0.1 deg/rt-hr mainly due to the higher APD noise that requires further investigations.

W5.66 16:00–17:30 ***Monitoring heat losses in a heating pipeline model using distributed temperature sensing***

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We demonstrate the application of distributed fiber optic temperature sensing based on optical frequency-domain reflectometry (OFDR) for the monitoring of the thermal behavior of a model of a partially buried heating pipeline and for the estimation of the heat losses in said pipeline. To do so, we continuously measured the temperature distributions in a test rig mimicking a water heating pipe after applying a temperature step change at the pipe inlet. The measurements were carried out using a commercially available OFDR system with a spatial resolution of 2.6 mm and a temperature resolution

of 0.1 °C. The distributed temperature measurements allowed obtaining the time evolution of the heat losses in the pipe sections located in air and buried in soil. These experimental results serve the validation of the thermal and fluid dynamics simulations carried out using COMSOL Multiphysics®.

W5.67 16:00–17:30 ***Railway track monitoring using distributed acoustic sensing (DAS) with standard telecom cable***

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We demonstrate the ability to detect ground vibrations in a railway environment using two Distributed Acoustic Sensing (DAS) configurations. The study employs the standard deviation of the differential phase over time (STDv) as a metric to evaluate the detection capabilities and spatiotemporal localization accuracy of both systems. A demonstration of rail train tracking is presented using a standard optical fiber telecom cable sheathed PEHD, with a detection range extending up to 40 km.

W5.68 16:00–17:30 ***Optical fiber gas sensors based on the interaction of evanescence waves with active layers detecting pure gases and liquid vaporous***

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This manuscript explores the potential for detecting gases and liquid vapours using a microfiber coated with a graphene oxide layer as an active coating. The graphene oxide interacts with target agents, altering the boundary conditions for light propagating within the microfiber and its evanescent wave. The paper details methods for producing microfibers, activating the glass surface, applying selected coatings, and identifying specific gases or liquid vapours. Analyses are conducted over a broad wavelength range of 600–1800 nm in transmission light modes. Results are presented for selected gases, such as pure hydrogen, a propane-butane mixture, and liquid vapours, including ammonia water and trimethyl phosphate. Measurements employed a differential method, comparing detection results with a reference system without the target agent, enabling the detection of small concentrations. Observed measurement differences remained below 5% of the initial power. For all tested factors, an increased power was observed as a function of the microfiber's exposure duration to gas or liquid vapour.

W5.69 16:00–17:30 ***Low noise refractive index sensing with short-length long-period gratings written with femtosecond laser***

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We present experimental results of refractive index measurements using femtosecond laser-written long-period gratings (LPGs) with periods ranging from 13 µm to 50 µm and a total grating length of only 4 mm. The peaks observed in transmission correspond to cladding modes with alternating L parity, as shown by calculations of EH modes using a 4×4 transfer matrix method, and their spectral positions and sensitivities show good agreement with experimental results. The peaks, which are well contrasted and easy to track with a commercial FBG interrogator, were monitored as the fiber was exposed to different glycerol concentrations in water. Sensitivities of the peak positions versus refractive index were extracted, showing values up to 421 nm/RIU and refractive index resolutions down to 1.1E-6 RIU, which demonstrate their great potential for biosensing. We also discuss trade-offs between sensitivity, measurement range, and linearity, offering recommendations for selecting optimal grating periods based on specific application requirements.

W5.70 16:00–17:30 ***Feature extraction of disturbance signal based on hilbert-huang transform for event recognition of Φ-OTDR***

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A phase-sensitive optical time-domain reflectometer (Φ-OTDR) vibration recognition method using Hilbert-Huang transform (HHT) for feature extraction is proposed. The experimental results show that the proposed method effectively recognizes the real disturbance events, and the recognition accuracy reaches 97.11% by training on a random forest (RF).

W5.71 16:00–17:30 ***Silica microlenses for extrinsic optical fibre sensors***

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Microlenses for extrinsic optical fibre sensors have been fabricated on fused silica using Ultrafast Laser-assisted Etching (ULAE) technique. Then the quality of a proof-of-concept manufactured microlens was evaluated by studying point-spread function profile and taking Airy disk as reference.

W5.72 16:00–17:30 ***A reflection scheme for optical chemical sensors via light-diffusing fibers and molecularly imprinted polymers***

Rosalba Pitruzzella[a], Filipa Sequeira[b], Chiara Marzano[a], Francesco Arcadio[a], Catarina Cardoso Novo[b], Luigi Zeni[a], Ricardo Jorge Figueiredo Oliveira[b], Maria Pesavento[c], Giancarla Alberti[c], Rogerio Nunes Nogueira[b], Nunzio Cennamo[a*]; [a]Dep. of Engineering, University of Campania Luigi Vanvitelli, Via Roma 29, 81031 Aversa, Italy; [b]Instituto de Telecomunicações, Universidade de Aveiro, Campus Universitário de Santiago, 3810 - 193 Aveiro, Portugal; [c]Dep. of Chemistry, University of Pavia, Via Taramelli 12, 27100 Pavia, Italy.*nunzio.cennamo@unicampania.it

In this work, a simple and low-cost optical-chemical sensor configuration based on Light-Diffusing Fibers (LDFs) and Molecularly Imprinted Polymers (MIPs) for the selective detection of 2-Furfuraldehyde (2-FAL) is developed and tested. The LDF and MIP are located in a C-shaped channel created into a polyvinyl chloride (PVC) hollow jacket. As a proof of concept, an MIP prepolymeric mixture for 2-FAL is poured into the channel with the LDF at the end and then polymerized via a thermal process. The optical-chemical probe is obtained via the silica LDF in a reflection sensing scheme to launch the light into the MIP and collect the backscattered one. Aqueous solutions perform binding tests at increasing 2-FAL concentration in contact with the MIP receptor via a 3D-printed measuring cell. The proposed sensor presents a limit of detection (LOD) estimated at 33 nM, similar to other sensitive optical-chemical sensor configurations.

W5.73 16:00–17:30 ***Limitations of OFDR measurements in civil structural health monitoring***

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In order to assure the structural health of civil infrastructures, distributed fiber optic sensing (DFOS) is often used and optical frequency domain reflectometry (OFDR) measurements are a potential candidate for long-term monitoring. From these measurements, information about the structure's state and its behavior are gathered. A very important aspect of long-term monitoring is the link to the zero measurement in order to be able to determine changes. There are multiple reasons, why the linkage

of measurements is not possible, like the wavelength range of the interrogators, broken sensors, vibrations during the measurement, wrong signal termination, change of the interrogator and large static or dynamic strain changes. These limitations present challenges for long-term monitoring of civil structures. Our investigation showed that different OFDR interrogators have different limitations and that solving the challenges imposed is not always possible. A knowledge of these limitations is crucial to design a functioning long-term monitoring setup.

W5.74 16:00–17:30 ***Femtosecond laser-written microstructured dual hole flat fibre pressure sensor***

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Flat fibre-based sensing technology benefits from their flexibility, defined orientation, and ease of integration with fibre composites, particularly for structural health monitoring. We demonstrate the fabrication and use of a silica microstructured flat fibre for pressure sensing, where the fibre cross section contains two sealed air holes to concentrate strain caused by external pressure to a central glass region, thus enhancing sensitivity. Femtosecond laser writing was used to inscribe a waveguide in the central region, along with two Bragg gratings at λ ~1.55 μm separated by 11 mm forming an interference sensor. The waveguide birefringence produces a Vernier effect in the reflection spectrum with highly pressure-sensitive peak and dip levels. Sensor characterisation in a nitrogen pressure chamber showed a peak-to-dip extinction ratio linear sensitivity of 0.83 dB/bar from 0 to 3 bar, before plateauing around 4 bar. Tests up to 5 bar confirmed excellent consistency under repeated pressure ramping.

W5.75 16:00–17:30 ***Microfluidic flowmeter using a PDMS-coated capillary***

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A novel flowmeter based on a whispering gallery modes (WGMs) microbottle resonator is proposed and experimentally demonstrated. WGMs are excited by a tapered fiber coupled perpendicularly to a microbottle resonator formed by polydimethylsiloxane (PDMS) deposited on the surface of the central region of a tapered silica capillary. The tapered capillary works as the microfluidic channel, allowing air to flow through the capillary with varying flow rates. A broadband light source was utilized as a heat source to heat the PDMS microbottle. The air flowing through the capillary causes a temperature decrease, leading to a refractive index (RI) decrease and a size shrinkage of the PDMS microbottle resonator. This change leads to a WGM resonance shift, the value of which can be linked to the airflow rate in the capillary. A sensitivity of 0.881 nm/sccm in the range of flow rates from 0 to 2.52 sccm has been demonstrated in our experiment. The proposed sensor can be used for low-volume flow rate measurement and offers the advantages of simplicity, high sensitivity, and miniature size.

W5.76 16:00–17:30 ***Organic solvents in-diffusion probe based on Bragg reflectors inscribed in polypropylene no-core optical fibers***

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The utilization of polypropylene (PP) as an optical material offers a number of attractive features, such as biocompatibility, high tensibility, and high chemical stability, rendering PP suitable for use with a great number of organic and inorganic solvents. In this work, we present the use of Bragg reflectors inscribed in PP no-core optical fibers in probing the in-diffusion of organic solvents (OSs) such as xylene and toluene. We show that PP fibers keep being operable after long-term immersion in OSs (up to 24 hours), while PP no-core optical fiber Bragg reflectors demonstrate gigantic red-shift (≈ 31 nm) after their immersion into toluene and xylene OSs, for characteristic times of 24h. The transduction behavior is described using polymer matrix swelling and refractive index changes due to molecular in-diffusion.

W5.77 16:00–17:30 ***Hybrid fibre-optic assemblies: a miniature, multi-functional cable for quasi- and fully- distributed measurements***

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A new, modular approach to fibre-optic sensing is presented, where different types of optical fibres and other wires are combined to compact, hybrid cable assemblies, customized for each application. These fibre-optic assemblies can be embedded or integrated in various settings, enabling multi-parameter sensing and the measurement of new parameters. In this work, we describe the fabrication process of these miniature, multi-functional cables and how it can be directly used for sensing purposes in three end-user inspired applications.

W5.78 16:00–17:30 ***Two-photon 3D printed Fabry-Perot cavity combined with a femtosecond fiber Bragg grating on a single fiber for simultaneous sensing of pressure and temperature at high temperatures***

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In this work, a Fabry-Perot (FP) microcavity is printed on the tip of a single mode fiber (SMF) through the use of two-photon polymerization (2PP) process and a solmer resin. A femtosecond fiber Bragg grating (FBG) is also inscribed close to the 3D printed FP cavity using the Point-by-Point (PbP) direct writing process. This structure is then tested at temperatures ranging from 20°C up to 600°C in order to determine the thermal sensitivity of the FP and FBG to temperature. Using similar femtosecond FBG and 3D printed FP cavity but written on separate test fibers, a characterization in pressure is also performed. The FP cavity exhibits a sensitivity to pressure of 430 pm/bar at ambient temperature and a thermal sensitivity starting at 0.15 pm/°C at 20°C and 1.37 pm/°C at 600°C. The femtosecond FBG shows a pressure sensitivity of -0.364 pm/bar at 20°C, and a thermal sensitivity of 9.8pm/°C and 15.4pm/°C at respectively 20°C and 600°C.

W5.79 16:00–17:30 ***Underground pipeline imaging using broadband fiber optic seismometer array***

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A fiber optic seismometer with a wide band from 120 s to 4000 Hz has been developed by using the inverted pendulum structure of space light interference and zero pole compensation technology. Combined with Kalman filtering and elliptic fitting demodulation, the phase noise of the system is reduced to 10 ng/√Hz@1 Hz. Based on this fiber optic seismometer, background noise imaging experiments were conducted at the site of known underground pipes. Comparing with ground penetrating radar and electrical seismometer, fiber optic seismometer successfully identified three pipelines with diameters of 2.8 m, 2.2 m, and 0.5 m at varying depth, indicating that its optimal imaging resolution has reached sub-meter levels and the performance better than that of electrical seismometer.

W5.80 16:00–17:30 ***Assessing electron radiation impact on Long Period Gratings: radiation saturation and recovery insights***

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In this study, we investigate the limitations of long period gratings (LPG) by exposing them to 5.5 MeV electrons, delivering a total dose exceeding 190 kGy, while the data is recorded in real time. To better understand the effects of radiation based on fiber composition, different commercially available optical fibers were selected. To gain a deeper understanding of the advantages and limitations of using this technology in specific applications, we also examined the long-term recovery of the devices after exposure, with intermediate assessments at up to twelve months' time. The main findings reveal that the LPG in B-Ge co-doped fiber remains responsive up to the full accumulated dose, with a resonance wavelength shift exceeding 35 nm and no signs of saturation. Furthermore, we demonstrated its potential for long-term data storage, with a 45% recovery toward initial values following post-irradiation stabilization. The novelty of this study relies in testing the limitations of LPGs fabricated both in sensitive and radiation hardened fibers while focusing on their potential i) to be reused post-irradiation and ii) to exhibit long-term data storage capabilities.

W5.81 16:00–17:30 ***Investigation of internal fine structure testing and defect analysis methods for fiber optic couplers***

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This paper presents a method for testing the internal fine structure and conducting defect analysis of fiber couplers. By applying a broad range of thermal stimuli to the fiber coupler, the invisible internal fine structures within the device are transformed into thermal strain distributions experienced by the optical fiber. The Optical Frequency Domain Reflectometry (OFDR) is then employed with millimeter-level ultra-high resolution to observe the strain along the fiber, thereby inverting the internal structure of the fiber coupler, this process enables further defect analysis and quality evaluation of the device.

W5.82 16:00–17:30 ***Pressure and temperature sensing with 3D nanoprinted structure integrated on optical fiber***

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Nanoprinted optical fiber sensors offer precision, versatility, and can operate in compact and challenging environments. This study uses a nanoprinted structure on the fiber tip to measure air pressure and temperature through a dual Fabry-Perot interferometer. The reflected interference pattern was analyzed, revealing three main frequency components processed with band-pass filters to assess the sensor response. Pressure measurements showed a linear response with a maximum sensitivity of 12 nm/MPa. Temperature measurements revealed sensitivities of -70.3 pm/°C (10–30°C) and -347.4 pm/°C (30–50°C). This work highlights the potential of nanoprinted, fiber-integrated sensors for precise, compact, and highly sensitive pressure and temperature monitoring.

W5.83 16:00–17:30 ***Temperature and relative humidity fiber optic sensing system for concrete monitoring***

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Concrete structures require precise temperature and humidity monitoring during curing to ensure optimal strength and prevent defects like cracking. A compact optical sensing system was developed using a single fiber that can be embedded directly within the concrete. The system functions as both a temperature and humidity sensor when paired with a spectral interrogation unit operating in the 1500-1600 nm range. Temperature monitoring is achieved through a Fiber Bragg Grating, while humidity sensing is facilitated by a Fabry-Perot interferometer at the fiber tip. The interferometer cavity is formed with a layer of polyvinylpyrrolidone (PVP). Initial air humidity sensor tests showed a significant change in the interference period with RH, demonstrating low hysteresis and high reproducibility. Calibration of one sensor revealed an approximately 3 nm period decrease when RH increased from 55% to 95%, with results suggesting a quadratic relationship between the interference period and RH values.

W5.84 16:00–17:30 ***Magnetic field measurement using Fabry-Perot fiber-optic sensor with 3D microstructures***

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Weak magnetic field measurement technology is valuable in geophysics, medical imaging, space exploration, and material science. Fiber-optic sensors, with their resistance to electromagnetic interference, compact size, high sensitivity, rapid response, and remote sensing potential, are widely used in magnetic field sensing. This experiment uses fiber-optic sensors to measure weak magnetic fields. The principle is based on Fabry-Perot (F-P) interference, and a 3D elastic micro-rhombus structure is printed on a single-mode fiber (SMF) end facet using femtosecond laser two-photon polymerization (TPP) lithography. An iron microsphere is added to make it magnetically sensitive. By monitoring the reflection spectrum of this sensor, a sensitivity of approximately -39.05 pm/mT is obtained in the 0-5.25 mT range.

W5.85 16:00–17:30 ***Opto-mechanical analysis of thermal stability of fiber coatings***

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Polymer coating layers are essential for the handling and proper function of optical fibers in their service environment. The analysis and monitoring of the elastic characteristics of coating layers are important for materials research and development, quality assurance, and maintenance. Most measurement protocols are destructive, require specialty samples, and may only be carried out offline. In this work, we monitor the velocities of dilatational acoustic waves in several coating layers of standard fibers, using forward Brillouin scattering processes. The measurements are non-destructive and performed over working fiber. Velocities are measured in three polyimide-based coating layers as functions of temperature up to 220 °C. Thermal changes in velocity are identified with 1% precision. The results suggest that the incorporation of nanoparticles within the polymer coating matrix improves its thermal stability.

W5.86 16:00–17:30 ***Development of a low-cost Raman spectroscopy platform for high-throughput analysis***

Guilherme Lopes*[a,b], António José Fernandes[b], Alexandre Carvalho[b], Carlos Marques[a]; [a]CICECO – Aveiro Institute of Materials, Physics Department, University of Aveiro, Aveiro 3810193, Portugal; [b]I3N and Physics Department, University of Aveiro, Aveiro 3810–193, Portugal

This study describes the development of a low-cost, high-throughput Raman spectroscopy platform for rapid sample analysis. The system consists of 3 main components: a CNC, a USB microscope and a Raman probe, providing a cheaper alternative to commercial systems. The platform combines automated particle coordinates identification with the microscope, followed by a Raman analysis to characterize the sample across a defined area. To validate the proposed system, polypropylene (PP) microplastics were scattered on a glass filter and subjected to the scan, which demonstrated the strengths, mainly associated with time and cost, related with this prototype.

W5.87 16:00–17:30 ***Multidimensional monitoring of gas pipeline leakage: an application of distributed multiparameter sensing based on hybrid UWFBG array***

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In this study, we present a practical application of a novel DXS interrogation technique using hybrid ultra-weak fiber Bragg gratings for multidimensional monitoring of gas pipeline leakage. During the measurement cycle, which includes air inflation and leakage events, the wavelength variation of FBG on the main pipeline demonstrates a linear correlation between pressure variation and wavelength shift. The demodulated vibration and wavelength data enable comprehensive analysis for leakage localization and classification.

W5.88 16:00–17:30 ***Stimulated Raman photothermal spectroscopy on an optical nanofiber for hydrogen detection***

Hanyu Liao[a,b,*], Shuangxiang Zhao[a,b], Kaiyuan Zheng[c], Hoi Lut Ho[a,b], Haihong Bao[a,b,*], Wei Jin[a,b]; [a]Department of Electrical and Electronic Engineering and Photonics Research Institute, The Hong Kong Polytechnic University, Hong Kong, China; [b]Photonics Research Center, The Hong Kong Polytechnic University Shenzhen Research Institute, Shenzhen, China; [c]Division of Environment and Sustainability, The Hong Kong University of Science and Technology, Hong Kong, China

We report stimulated Raman photothermal spectroscopy (SRPTS) on an optical nanofiber (NF) for tracing hydrogen. The NF is capable of supporting an effective mode field area as small as ~1 μm^2, which significantly enhances both the stimulated Raman scattering and the subsequent photothermal process. Due to the high thermo-optic coefficient of silica, the heating induced phase change of a NF can also be much higher than free-space systems. With an NF of ~50 mm in length and ~700 nm in diameter, we have demonstrated hydrogen detection down to 274 ppm under 1 bar with 350 mW pump and 150 mW Stokes power and 1 s lock-in time constant.

W5.89 16:00–17:30 ***Pipeline leaks acoustic detection using mechanically amplified fiber Bragg gratings sensors and artificial intelligence***

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An acoustic sensor based on FBGs is proposed for pipeline leak detection. To enhance its sensitivity, a mechanical amplification structure incorporating a hanging mass has been designed and fabricated. Additionally, to improve versatility and detection performance, an Artificial Intelligence algorithm based on an autoencoders has been implemented to perform a real-time leak detection.

W5.90 16:00–17:30 ***Topological sensing with plasmons***

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Topological photonics, leveraging concepts from condensed matter physics, offers transformative potential in the design of robust optical systems. This study investigates the integration of topologically protected edge states into plasmonic nanostructures for enhanced optical sensing. We propose a toy model comprising two chains of metallic filaments forming a one-dimensional plasmonic crystal with diatomic-like unit cells, positioned on a waveguide. The system exhibits edge states localized at the boundaries and a central defect, supported by the Su-Schrieffer-Heeger (SSH) model. These edge states, characterized by significant electric field enhancement and topological robustness, are shown to overcome key limitations in traditional plasmonic sensors, including sensitivity to noise and fabrication inconsistencies. Through coupled mode theory, we demonstrate the potential for strong coupling between plasmonic and guided optical modes, offering pathways for improved interferometric sensing schemes. This work highlights the applicability of topological photonics in advancing optical sensors.

W5.91 16:00–17:30 ***Polarization sensing for optical network security: a comparative study of 1G and 200G systems***

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Polarization state changes in optical fibers are valuable for improving network security. This study uses a robotic arm to compare the polarization sensing capabilities of 1Gbit SFP and CFP2 coherent transceivers under controlled fiber manipulations. Stokes vectors extracted with a 4-diode polarization analyzer are evaluated using mean squared error (MSE). The 1G system shows higher sensitivity

to fiber manipulations, achieving lower MSE, but is influenced by signal spikes during force application. The 200G system offers greater stability but reduced sensitivity to fine birefringence changes, leading to higher MSE.

W5.92 16:00–17:30 ***NV centres in diamond for magnetic field quantum sensing***

Matthew Green*, Matthias Fabian, Tong Sun, Kenneth T.V. Grattan; Department of Engineering, City St George's, University of London, Northampton Square, London EC1V 0HB, United Kingdom

Nitrogen-Vacancy (NV) centres in diamond have been shown to possess a quantised energy structure that allows for a number of macroscopic parameters to be measured with a high level of sensitivity. The process of sensing magnetic fields can be achieved through the behaviour of the NV centre's electron spin triplet states using the separation of field-dependent and independent states, inferred by applying a microwave frequency to drive transitions. Observation of the states is achieved through optical pumping and stimulated emission, where the intensity of the fluorescent emission and frequency of the applied microwaves relates to the magnitude of the magnetic field the NV centre experiences. The optical method of sensing can be facilitated using optical fibres in which NV diamond particles are embedded between the core and outer fibre layers, leading to a robust platform for further practical applications with strong resistance to external interference.

W5.93 16:00–17:30 ***Low-cost versatile optical fiber sensor for structural health monitoring of reinforced concrete structures***

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Reinforced concrete is essential for infrastructure due to its durability and affordability. However, aging concrete can decay internally before visible damage appears, leading to costly repairs and safety risks. This study uses multimode optical fibers to monitor concrete curing, water ingress, humidity, carbonation, and rebar corrosion. Sensors detect changes in reflection at the fiber tip, using LEDs and photodiodes. They monitor water throughout the concrete lifecycle, including curing, relative humidity changes and water intrusion through changes in the refractive index in the vicinity of the fiber tip. Colorimetric changes in cement paste and iron-thin film track carbonation and corrosion. The sensors are cost-effective and offer a broad monitoring scope, making them ideal for structural health monitoring of reinforced concrete.

W5.94 16:00–17:30 ***'Measuring the Monument' – fibre optic sensor systems show why Hooke's and Wren's plans for a giant telescope within the Monument in London failed***

Matthias Fabian[a,b,c], Joanna M. Coote[a], Philip J. Thomas[c], Michael Mainelli[d], Tong Sun[a,b], Kenneth T. V. Grattan[a,b,c,*]; [a]City Optotech Ltd, Northampton Square, London, EC1V 0HB, UK; [b]School of Science & Technology, City St George's, University of London, London EC1V 0HB, UK; [c]Worshipful Company of Scientific Instrument Makers, 9 Montague Close, London, SE1 9DD, UK; [d]Lord Mayor of London (2023-24), Guildhall, PO Box 270, London, EC2P 2EJ, UK.*k.t.v.grattan@city.ac.uk

Fibre optic sensor systems have often been used for structural health monitoring applications, usually on bridges, in tunnels and sewers and in various infrastructure where installation is usually only affected by access. This work has tackled a problem of structural monitoring on one of London's iconic historic buildings, where installation of the chosen fibre optic sensors had to be very carefully planned and agreed with the building owners who imposed severe limits to avoid creating any damage to the structure. Given these restrictions, a fibre optic sensor system was designed and installed to enable the accurate determination of the structural parameters of the building, solving a 350-year-old question of why the building was not able to be used for its original subsidiary purpose, from its design by Robert Hooke and Christopher Wren, as a telescope. Results of on-going research and analysis are reported.

W5.95 16:00–17:30 ***Generation of lossy mode resonances in a printed optical waveguide***

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This work demonstrates the generation of a Lossy Mode Resonance (LMR) on a printed waveguide and the potential use of the structure for refractive index detection. The printed waveguide was fabricated using NOA 61 as the ink, a needle of 50 µm internal diameter and an electrohydrodynamic (EHD) printing machine. The waveguide is coupled to the input/output fibers using a micro-positioning system. A SnO2 thin film was deposited onto the waveguide using a DC sputtering machine. The LMR spectrum generated is obtained while the sensor is in contact with ultrapure water. The shift of the LMR spectrum was analyzed as a function of exposure to different refractive indices. The sensitivity, FWHM, and FOM of the evanescent-based printed optical sensor were determined.

W5.96 16:00–17:30 ***Anisotropic plasmonic nano emitters to excite surface plasmon polaritons on thin film-coated tapered optical fibers***

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Phase-matching for exciting surface plasmon resonance (SPR) in plasmonic films is typically achieved through prism, optical fiber, or grating-assisted coupling. We recently showed that plasmonic nanospheres can act as local emitters, exciting SPR waves on thin films – termed nanoparticle-induced SPR (NPI-SPR). However, optical fiber geometry and nanoparticle anisotropy impact were unexplored. In this study we found that an etched multimode fiber with a 200 µm core diameter, taper ratio of 4, and etching angle of 20° optimizes interaction with nanoparticles. Also, tuning the nanoparticle aspect ratio from 1 to 3 shifts the NPI-SPR band from 780 to 1580 nm, with excitation dependent on the incident light angle and polarization. For light incident parallel to the film, refractive index sensitivity exceeding 1000 nm/RIU is achieved. This efficient light emission enhances plasmonic nanoparticle-on-film structures with nanoantenna emission, advancing optical fiber plasmonic chemical and biosensors.

W5.97 16:00–17:30 ***Repeatability of vibration-based damage detection on rolling element bearings with FBG sensors***

Sidney Goossens[a,b,*], Panagiotis Mantas[c,d], Damilare Ojo[a,b], Octavian Axinte[a,b], Alexandre Mauricio[c,d], Konstantinos Gryllias[c,d], Francis Berghmans[a,b], [a]Brussels Photonics (B-PHOT), Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium; [b]FlandersMake@VUB - BP&M, Pleinlaan 2, 1050 Brussel, Belgium; [c]LMSD Division Mecha(tro)nic System Dynamics, Department of Mechanical Engineering, KU Leuven, Celestijnenlaan 300, Box 2420, B-3001 Leuven; [d]FlandersMake@KULeuven, Celestijnenlaan 300, Box 2420, 3001 Leuven, Belgium.*sidney.goossens@vub.be

Current state-of-the-art condition monitoring techniques for rolling element bearings, such as accelerometers and microphone arrays, face limitations in sensor placement and susceptibility to electromagnetic interference (EMI). This study addresses these challenges by employing fiber Bragg grating (FBG) sensors, which offer high sensitivity and immunity to EMI, for real-time monitoring of vibration signals directly on the stationary and rotating parts of the bearings. We created 0.5 mm micromachined damage on the outer raceway to simulate early-stage faults and assessed the probability of detection by performing repeated measurements. Our results show that FBG sensors can accurately detect and locate faults at early stages, with clear differences in damage indicators (DI) between

healthy and faulty bearings, although large uncertainties in the detection of faulty signals limit the probability of detection. By enabling more precise fault location and improving diagnostic capabilities, this approach has the potential to enhance operational efficiency, safety, and cost savings in industrial applications with and prototyping of rotating equipment.

W5.98 16:00–17:30 ***Molecularly imprinted optical fibre sensor for detection of nitroglycerin***

Nancy S. Whittaker*[a], Pavel Čurda[b], Beatriz Rosales-Reina[c], Tong Sun[a], Kenneth T.V. Grattan[a], Kate Khan[d], Alex Parker[e], Vitezslav Stranak[b], Mateusz Śmietana[f], Cesar Elosúa[c]; [a]City St George's University of London, London, United Kingdom, EC1V 0HB; [b]University of South Bohemia, Branisovska 1760 Ceske Budejovice; [c]Universidad Pública de Navarra (UPNA), 31006 Pamplona, Spain; [d]Department for Transport, Great Minster House, 33 Horseferry Rd, London, United Kingdom, SW1P 4DR; [e]Smiths Detection, Century House, Maylands Avenue, Hemel Hempstead, Hertfordshire, United Kingdom, HP2 7DE [f]Warsaw University of Technology, 00-662 Warsaw, Poland

In this study, a nitroglycerin (NG) sensor has been developed, utilizing indium tin oxide (ITO) coated optical fibres, molecularly imprinted polymer (MIP) and xerogel technologies. Nitroglycerin detection remains of great importance in the defense and security industry and therefore, steps towards sensitive and specific detection technology are important to be explored. Experimental methods reported focus on the removal of NG from the MIP, evidenced by a change in wavelength shift, (38.62 nm), indicating that NG was fully removed, before exploring the rebinding and subsequent quantification of NG uptake in follow-up analysis. A non-imprinted polymer (NIP) has been developed in parallel and measurements made, to compare the performance and behaviour of the MIP. The chemical sensor scheme developed here shows promise for detecting NG using the technologies discussed, and while most relevant to the defense and security applications, they also have side applicability to different targets for other industries.

W5.99 16:00–17:30 ***Early leak detection in wastewater pipelines using fibre Bragg grating sensors***

Matthias Fabian[a,b,*], Joanna M Coote[b], Richard Scott[a], Tong Sun[a,b], Kenneth T V Grattan[a,b], Heriberto Bustamante[c], Timothy Hill[c], James McCulloch[c], Simon Tait[d], Kirill Horoshenkov[d]: [a]City St George's, University of London, London, EC1V 0HB, UK; [b]City Optotech Ltd., London, EC1V 0HB, UK; [c] Sydney Water Corporation, Parramatta, NSW 2124, Australia; [d]The University of Sheffield, S10 2TN, UK.*matthias.fabian.1@city.ac.uk

We report on improvements in the design and data processing of a ruggedised, highly sensitive fibre-optic pressure sensor for use in pumped sewer mains. Leak detection and localisation tests were carried out on a plant scale test rig using mains water for a range of leak sizes. The leak-induced pressure drop resolution achieved is better than 100Pa (1mbar) which corresponds to a leak size of approximately 2mm (in a pipe of 100mm in diameter and a flow rate of 16 litres per second).

W5.100 16:00–17:30 ***Hybrid sensor based on a single segment of hollow-core microstructured optical fiber for simultaneous measurement of pressure and temperature***

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The sensor displays distinct sensitivities for each parameter, with the air cavity exhibiting a pressure sensitivity of (4.01 ± 0.04) nm/MPa and temperature sensitivity of (0.66 ± 0.06) pm/°C, while the silica cavity demonstrates a pressure sensitivity of (0.914 ± 0.004) nm/MPa and a temperature sensitivity of (8.27 ± 0.07) pm/°C.

W5.101 16:00–17:30 ***Mind the splice: ultra-high sensitivity refractometer based on thin-wall silica capillary tube***

Mariline M. Costa[a], Ana I. Freitas[a,b], Jörg Bierlich[c], Marta S. Ferreira*[a]; [a]i3N & Physics Department, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal; [b]Faculty of Exact Sciences and Engineering, University of Madeira, Campus da Penteada, 9020-105 Funchal, Portugal; [c]Leibniz Institute of Photonic Technology, Albert-Einstein-Straße 9, 07745 Jena, Germany. *marta.ferreira@ua.pt

In light of the increasing demand for sensing devices with larger sensitivities and precision, this work presents an optical fiber sensor based on multimode interference, fabricated by manipulating the fusion parameters for a silica capillary tube spliced between two sections of singlemode fiber. The sensor, with a length of ~2.5 mm, is studied for a variation of refractive index ranging from 1.3342 RIU to 1.3452 RIU. To circumvent the complex spectral response of the sensor, a frequency filtering of the response strategy is implemented, resulting in sensitivities of 1391.0 nm/RIU and 2807.5 nm/RIU, and a correspondent resolution of 7.6×10^(-5) RIU and 9.4×10^(-4) RIU, when considering the first two main frequencies of the spectral response.

W5.102 16:00–17:30 ***Hydrophobicity level detection of superhydrophobic glass-composite coatings based on a fibre-hole-fibre structure***

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A fibre-hole-fibre structure (FHFS) embedded within glass-fibre reinforce polymer (GFRP) is proposed for monitoring the hydrophobicity level of superhydrophobic GFRP coatings. Monitoring changes in the optical power transmission through the FHFS allows the detection of water droplets within a hole positioned in the middle of the optical fibre. The relationship between the hydrophobicity level of the GFRP coating and the transmitted optical power is analysed for different hole sizes. Using a proof-of-concept experimental setup based on a series of FHFSs with different hole dimensions, the proposed approach effectively identifies hydrophobicity levels, allowing the detection of eventual material failures and worn coatings with reduced hydrophobicity.

W5.103 16:00–17:30 ***Reversible pH sensing utilizing U-bent optical fibers coated with a layer-by-layer application of polymer multilayers***

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This study presents a U-shaped evanescent wave optical fiber with a layered nano-thin film of PAH and PAA, demonstrating its application as a pH sensor. The optical fiber demonstrated that decreased light transmittance intensified as the number of films increased, indicating a rise in the thin film's refractive index. Highly sensitive pH sensing is due to changes in the electrostatic interactions between the layers of the PAH/PAA film, as H+ and OH– ions adsorb in the aqueous solution, causing the thin film to swell and shrink repeatedly.

W5.104 16:00–17:30 ***Fiber-optic EFPI acoustic emission sensor with bulk silicon micromachined membrane***

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Fiber-optic extrinsic Fabry-Pérot interferometer (EFPI) sensor was developed by implementing a micromachined membrane, as a second reflecting surface, to the end facet of fiber-optic connector. The membrane was fabricated by depositing 3 layers on a silicon wafer and using bulk silicon

micromachining technique. The material and dimensions were carefully chosen with an FEM to achieve sensitive and robust action in the target frequency range of 20~120 kHz. The prepared membranes could be easily implemented into the right position on sensor frame, which formed Fabry-Pérot cavities with accurate cavity length control due to the novel micromachining design. The constructed EFPI sensors successfully performed preliminary acoustic emission measurements and demonstrated high sensitivity with no noticeable damage to the membranes during the packaging process and the acoustic pressure measurements. The results of preliminary time difference experiments were closely matched with the ideal values, promising the feasibility of accurate time difference of arrival localization.

W5.105 16:00–17:30 ***Optical fibers used as structural sensing elements in a tensegrity structure for force measurement and localization***

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This paper presents preliminary investigations of the force/torque sensing capabilities of a tensegrity-based structure. The design includes two rigid bodies which are connected by a tension spring and three interferometric fiber optic sensors in a pre-stressed state. In this way, the fibers do not only provide the sensing capability, but also act as pre-stressed load-bearing structural components. In this preliminary investigation, we show that the cumulative strain of the fibers detected is proportional to a load applied to the structure. We also demonstrate a simple approach to localize the point of load application based on fiber optic strain measurements. The structure's design enables scalability and customizable mechanical properties, making it adaptable for a wide range of measurement applications.

W5.106 16:00–17:30 ***An improved deconvolution beamforming algorithm based on fiber optic microphone array for acoustic imaging***

Jindong Liu[a], Yi Huang[a], Chengyong Hu[a], Yuanhang Ma[a], Chuanlu Deng[a], Xiaobei Zhang[a], Sujuan Huang[a], Qi Zhang[a], Qun Li[b], Jian Shao[b], Peng Wu[b], Yuncai Lu[b], Tingyun Wang*[a]; [a]Key Laboratory of Specialty Fiber Optics and Optical Access Networks, Joint International Research Laboratory of Specialty Fiber Optics and Advanced Communication, Shanghai Institute for Advanced Communication and Data Science, Shanghai University, Shanghai 200444, China; [b]State Grid Jiangsu Electric Power Research Institute, Nanjing 211103, China.*tywang@shu.edu.cn

An improved deconvolution beamforming algorithm has been proposed to achieve imaging localization using fiber optic microphone arrays. The method accelerates the solution of the deconvolution approach for the mapping of acoustic sources 2 (DAMAS2) by introducing a fast iterative shrinkage-thresholding algorithm (FISTA), and optimizes the point spread function (PSF) combined with regularized filtering to improve the imaging resolution. Experimental results demonstrate that the method takes only 3.799 seconds for 200 iterations, which can significantly reduce the runtime while improving the imaging resolution.

W5.107 16:00–17:30 ***Analyzing the laser-driven dynamics of SU-8 microcantilevers with optical fiber Fabry-Perot cvity***

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In this paper, we first theoretically study the behavior of an SU-8 microcantilever under thermoelastic effects, secondly, the device fabrication was carried out using optical lithography. The cantilevers, with thicknesses of 78 μm, width of 340 μm and, a length of 1068 μm, were fabricated from SU-8. Experimental verification of thermoelastic excitation was conducted using a 450nm laser, and the behavior of the microcantilever dimension changes was analyzed using an optical Fabry-Perot cavity. In this configuration, the cantilever acts as a low reflecting mirror within a Fabry-Perot cavity. The experimental results show a displacement of approximately 860 nm, which is in good agreement with our simulation.

W5.108 16:00–17:30 ***2.7 µm surface plasmon resonance fiber optic sensors***

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In this work, we demonstrated a mid-infrared surface plasmon resonance (SPR) fiber optic sensor utilizing a D-shaped multimode silica optical fiber coated with a 105 nm indium tin oxide (ITO) layer. The sensor presented resonance at approximately 2700 nm with a refractive index sensitivity of 1055.33 nm/RIU Compared to that of visible light, mid-infrared wavelengths enable deeper evanescent field penetration, allowing greater probing depths for biological samples. Moreover, the overlap of the mid-infrared spectrum with the molecular fingerprint region offers substantial potential for advanced gas detection applications.

W5.109 16:00–17:30 ***Ultra-hiigh-SMSR femtosecond apodized FBG based on variable pulse number Inscription technology***

Yuanjing Zhao[a,b], Wenzhu Huang*[a,b], Wentao Zhang[a,b], Fang Li[a,b]; [a]Institute of Semiconductors, Chinese Academy of Sciences, Beijing 100083, China; [b]Center of Materials Science and Optoelectronic Engineering, University of Chinese Academy of Sciences, Beijing, 100049, China.*hwzhu@semi.ac.cn

This paper reports a novel femtosecond direct-writing apodized fiber Bragg grating (FBG) technology based on variable pulse number control. By combining coupled-mode theory and the transfer matrix method, a theoretical model for apodized FBGs was constructed. Simulations revealed the relationship between the maximum pulse number and the SMSR of the FBG, demonstrating that the variable pulse number technique can precisely control the refractive index modulation depth of the FBG, achieving an ultra-high-SMSR. Experimental results show that the apodized FBG achieves an SMSR of up to 29.18 dB, which represents the highest level reported to date.

W5.110 16:00–17:30 ***Polarization-switched fiber optic ring laser for L-band multiwavelength remote sensing applications***

Iñaki Janices[a], Uxue San-Martin[a], Alvaro Salinas[a], Arturo Sanchez-Gonzalez[a,b], Maria Jose Erro[a,b], Rosa A. Perez-Herrera[a,b], and Santiago Tainta[a,b]*; [a]Dpt. Electrical, Electronic and Communication Engineering, Public University of Navarra, 31006 Pamplona, Spain; [b]Institute of Smart Cities, Public University of Navarra, 31006 Pamplona, Spain.*santiago.tainta@unavarra.es

This work presents the experimental demonstration of a three-channel remote sensor that operates in the L-band. It is based on a fiber ring laser cavity, formed by a semiconductor optical amplifier and three fiber Bragg gratings used both for the selection of the operating wavelengths and the sensing. A polarization-controller allows the activation of one, two or the three emission wavelengths simultaneously. The sensing elements can be situated in a remote localization, without compromising the temperature sensitivity of the experimental setup. To validate this functionality, a 25 km standard single-mode fiber optic reel is incorporated between the FBG-based sensors and the cavity, demonstrating the system's ability to perform long-range sensing while preserving signal integrity and operational reliability.

W5.111 16:00–17:30 ***Functional near-infrared spectroscopy sensor using a combined short channel regression and frequency-division multiplexing***

Chang Hyun Park, Dongyoung Jo, Jeesu Kim, Chang-Seok Kim*; Department of Cogno-Mechatronics Engineering, Pusan National University, Busan, 46241, Korea.* ckim@pusan.ac.kr

We designed and developed an fNIRS system that suppresses this noise by integrating a short-channel-based signal correction method and frequency division multiplexing (FDM). The results indicated that after applying short-channel regression, the effect size (Cohen's d) increased by approximately 0.9 compared to the measurements taken before applying short-channel regression. Additionally, a significant difference in hemodynamic responses was observed between the digit span task and the

control task. These findings suggest that the proposed fNIRS device is unaffected by ambient light and that short-channel regression effectively reduces noise interference. Consequently, this system can deliver accurate and stable measurements of brain activity, even in conditions where managing ambient light and surface noise is complicated.

W5.112 16:00–17:30 ***Displacement sensor based on an external cavity fiber laser for non-contact photoacoustic sensing***

Wontae Choe[a], Sang Min Park[b], Hansol Jang[c], Hwidon Lee[a,b], Jeesu Kim[a,b], Chang-Seok Kim[a,b,*]; [a]Department of Optics and Mechatronics Engineering, Pusan National University, Busan, South Korea; [b]Engineering Research Center for Color-Modulated Extra-Sensory Perception Technology, Pusan National University, Busan, South Korea; [c]Ground Technology Research Institute, Agency for Defense Development, Yuseong-gu, Daejeon 34186, Korea.*ckim@pusan.ac.kr

We demonstrate a novel displacement sensor with a narrow-linewidth external cavity laser (ECL) for non-contact optoacoustic sensing. The proposed displacement sensor features scalable phase sensitivity by precisely controlling the interferometer's initial optical path length difference (OPD). Experimental validation demonstrates nanometer-scale displacement sensing using a piezo actuator. A black absorbing target is used for PA signal acquisition, and a phase shift of about 0.7 radians is achieved.

W5.113 16:00–17:30 ***Enhancement of fiber-optic sensor performance through hyperbolic dispersion engineering***

João P. M. Carvalho*[a,b], João P. Mendes[a], Luís C. C. Coelho[a,b], José M. M. M. de Almeida[a,c]; [a]Centre for Applied Photonics, Institute for Systems and Computer Engineering, Technology and Science - INESC TEC, Rua do Campo Alegre, 4169-007 Porto, Portugal; [b]Dept. of Physics and Astronomy, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 4169-007 Porto, Portugal; [c]Department of Physics, School of Science and Technology, University of Trás-os-Montes and Alto Douro, 5000-801 Vila Real, Portugal

Optical fibers have been extensively applied in optical sensing platforms for their large bandwidth, light weight and accessibility. This work presents a theoretical analysis of an optical fiber surface plasmon resonance system for refractometric sensing applications. The device consists of a multilayer hyperbolic metamaterial (HMM) composed of concentric Au/TiO2 alternate layers in optical fiber matrix. HMMs exhibit hyperbolic dispersion (HD) and the interaction of different plasmonic modes at each interface of the HMM is reported to enhance light-matter coupling, leading to an increased refractometric sensitivity. The HD and its effects on sensor performance are numerically investigated by effective medium theory (EMT) and backed by the exact transfer matrix method (TMM). The maximum sensor performance was attained for a configuration with 2 bilayers with 30 nm thickness for a metal fill fraction (ρ) of 0.7, achieving a figure of merit (FOM) of 18.45. A direct comparison with a plasmonic Au optical fiber sensor returned an optimized FOM of 5.74, achieving over a three-fold increase in sensor performance, assessing the potential of HMM as highly refractometric sensitive platforms.

W5.114 16:00–17:30 ***Multi-Fiber optic sensing system for eco-friendly gas-insulated switchgear condition monitoring***

Jonghyun Eom[a,*], Hwee-Kwon Jung[a], Young-Guk Choi[b], Jun-Geun Shin[b], Hyo-Jong Kim[b]; [a]Intelligent Technology Research Center, Korea Photonic Sensor Research Center(KOPTI); [b]Optical Precision Measurement Research Center, Korea Photonic Sensor Research Center(KOPTI), 9, Chumdan Venture-ro 108beon-gil, Buk-gu, Gwangju, Republic of Korea. *jheom@kopti.re.kr

A multi-fiber optic sensor system was developed for real-time monitoring and diagnostics of eco-friendly gas-insulated switchgear (eGIS). The proposed system is capable of accurately measuring internal temperature, pressure, and partial discharge occurrences within the eGIS.

W6 Exhibitors Plenary Session

17:30–19:00

CHAIR **Prof. António Barbosa Lobo Ribeiro**
Universidade Fernando Pessoa (Portugal)

W7 Committees + Chairs Dinner

20:00–23:00

Thursday May 29th 2025

Th1 Plenary Session III

CHAIR **Prof Julian Jones**
Heriot-Watt University (United Kingdom)

Th1.1 **Prof. Prof Roberto Osellame**
8:30–9:30 CNR - Institute for Photonics and Nanotechnologies (Italy)

Optical Sensing and Imaging in Femtosecond-Laser-Written Optofluidic Lab-on-Chip

The integration of optical imaging and sensing in lab-on-a-chip devices is transforming the field of microfluidic analysis. By enabling real-time, high-sensitivity detection in small volumes, these technologies facilitate breakthroughs in healthcare, environmental analysis, and research, bridging the gap between laboratory precision and portable diagnostic solutions. Femtosecond laser micromachining is rapidly becoming a widely appreciated method for processing transparent materials. Being contactless, maskless, cost-effective and capable of 3D structuring, it raised great interest both in scientific as well as in industrial applications. Its properties are particularly advantageous for the realization of lab-on-chip devices where the combination of microfluidics and photonic components enable the integrated manipulation and high-quality imaging of biological samples, from organoids to single cells.

Th2 In Memoriam
9:30–9:45

Th3 Session *Biochemical Sensing*
9:45–11:15

CHAIRS **Prof. Eric Fujiwara**
State University of Campinas (Brazil)

Dr. Stephen Warren-Smith
University of South Australia (Australia)

Th3.1 9:45–10:15 **Prof Andrea Cusano**
INVITED Universidad di Sannio (Italy)

Lab on Fiber Technology: Towards Theranostics Endoscopes

In recent decades, the old "one-size-fits-all" approach to the treatment of various clinically relevant pathologies has been replaced by a personalized model in which the therapeutic strategy is based on the biological characteristics of the patient's disease.

At the same time, the last two decades marked a turning point in the optical fiber technology roadmap. leading the development of the so called Lab on Fiber (LOF) technology, which in turn represents one of the most suitable technology to support the translation towards the personalised medicine paradigm.

Indeed, according to the Lab on fiber revolution, optical fibers cease to be just a simple waveguide, and become a new all-around technological platform where different kind of passive materials and structures at nano-scale (i.e. the labs) are suitably integrated around, on top or inside the fiber itself, allowing for the realization of advanced multifunctional optrodes.

Considering the technological maturity achieved so far, at both fabrication and application level, here we will review recent advances in the field with special focus on the development of novel generation of multifunctional in vivo tools for advanced diagnostics (liquid and tissue biopsies) and to support loco-regional therapies through light triggered intelligent (targeted) nano-carriers.

Th3.2 10:15–10:30 ***Multifunctional integrated fiber-optic probe for in vivo tumor identification, therapy, and efficacy assessment***

Zesen Li[a,b], Yang Ran*[a,b], Bai-Ou Guan[a,b]; [a]Guangdong Provincial Key Laboratory of Optical Fiber Sensing and Communications, Institute of Photonics Technology, Jinan University, Guangzhou, 510632, China; [b]College of Physics & Optoelectronic Engineering, Jinan University, Guangzhou, 510632, China.
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In this work, a multifunctional integrated fiber-optic probe was developed by co-modifying pH indicator, temperature indicator, and photothermal agent on the surface of one single tapered optical fiber. The excitation bands of these agents do not overlap with each other. Thus, the fiber-optic probe exhibited different functionals under different excitation wavelengths without crosstalk. Before therapy, the probe can reveal the tumor acidification gradient to realize tumor edge identification. During therapy, the photothermal agent can convert light energy to heat and thus realize photothermal therapy (PTT). At the same time, through temperature monitoring, precise control of therapeutic dose can be achieved. After therapy, through the dynamic monitoring of pH, rapid efficacy assessment can be realized. This study provides a paradigm for the multifunctional integration of fiber-optic theranostics probes, which is expected to play an important role in oncology clinical medicine and tumor mechanism research.

Th3.3 10:30–10:45 ***Pharmaceutical chemical sensing in hollow-core anti-resonant fiber with surfaces functionalized by semiconductor nanoparticles***

Han Wang[a], Wenjing Gao[a], Yu Zheng[a], Ruochen Yin[b], Haihu Yu[a*], Xin Jiang[b*], [a]National Engineering Research Center of Fiber Optic Sensing Technology and Networks, Wuhan University of Technology, Wuhan 430070, China; [b]Russell Centre for Advanced Lightwave Science, Shanghai Institute of Optics and Fine Mechanics and Hangzhou Institute of Optics and Fine Mechanics, Hangzhou 311421, China.*hhyu@whut.edu.cn, xin.jiang@r-cals.com

Hollow-core fibers provide an excellent platform for a variety of research initiatives due to their outstanding characteristics, such as broadband light transmission, enhanced light-matter interactions, ultra-low nonlinearity, low latency and waveguide dispersion. Among these investigations, hollow-core fiber-based chemical sensors have attracted significant interest and show considerable potentials. In this study, we present a novel approach for measuring aqueous tetracycline molecules by modifying the inner surface of a double-nested hollow-core anti-resonant fiber with deposited nanoscale semiconductor CsPbBr3 particles of perovskite structures. The chemical sensing primarily relies on the fluorescence quenching of CsPbBr3 nanoparticles upon reacting with aqueous tetracycline. These findings offer a reliable, compatible, and promising solution for chemical and biological sensing of aqueous substances in fiber-based systems.

Th3.4 10:45–11:00 ***Fiber ultrasound transducer array for in vivo anatomic and functional photoacoustic imaging of mouse glioma***

Jun Ma*[a,b], Zitao Chen[a,b], Yuhan Wu[a,b], Hexiang Xu[a,b], Bai-Ou Guan[a,b], [a]Guangdong Provincial Key Laboratory of Optical Fiber Sensing and Communications, Institute of Photonics Technology, Jinan University, Guangzhou 510632, China; [b]College of Physics & Optoelectronic Engineering, Jinan University, Guangzhou 510632, China.*jun.ma@jnu.edu.cn

A dual-band fiber ultrasound transducer array is developed for photoacoustic computed tomography (PACT) to simultaneously measure both low-frequency signals (~ 2.5 MHz) from deep tissues and high-frequency signals (~ 20 MHz) from fine structures. The PACT array system comprises eight dual-band fiber ultrasound transducers and has a 150° angular coverage, capable of in vivo anatomic and functional imaging of the whole mouse brain with the depth up to ~ 1 cm and a high spatial resolution of ~ 135 μm. Visualization of the oxygen saturation within the brain glioma demonstrates its potential for brain functionality study and disease diagnosis.

Th3.5 11:00–11:15 ***Metasurface-based Lab-on-fiber biosensor for label-free detection of vitamin D***

M. Cusano[a], G. Quero[b], P. Vaiano[c], P. Cicatiello[d], M. Principe[c], A. Micco[a], M. Ruvo[e], M. Consales*[c], A. Cusano*[c]; [a]Centro Regionale Information Communication Technology, Benevento, Italy I-82100; [b]University of Molise, Dept. of Biosciences and Territory, Pesche, Italy I-86090; [c]University of Sannio, Dept. of Engineering, Optoelectronics Group, Benevento, Italy I-82100; [d]University of Naples Federico II, Dept. of Chemical Sciences, Napoli, Italy I-80126; [e]National Research Council, Institute of Biostructure and Bioimaging, Napoli, Italy I-80131.*consales@unisannio.it; a.cusano@unisannio.it

The need for effective vitamin D assessment has emphasized the importance of developing rapid, accurate, and user-friendly detection tools, particularly for integration into Point-of-Care (PoC) diagnostic devices. Detecting 25-hydroxyvitamin D3 (25(OH)D3) poses significant challenges due to the sample preparation and small molecular size, which imposes extreme sensitivity. This work introduces a novel label-free Lab-on-Fiber (LoF) biosensing platform for the detection of 25(OH)D3. The sensor integrates plasmonic metasurfaces onto the tip of a single-mode optical fiber, offering high sensitivity combined with a compact design. The metasurface-enhanced LoF biosensor, characterized by high affinity and specificity, demonstrated excellent performance, enabling detection of 25(OH)D3 across clinically significant ranges (4–160 ng/mL) in both buffer solutions and complex biological matrices. These findings confirm the platform's capability to detect small molecules in a label-free configuration, with sensitivity and specificity comparable to conventional clinical methods. This makes it a promising tool for the development of cost-effective, quick, and easy-to-use PoC diagnostic devices.

Th4 Session
11:30–13:00

Environment, Security, Defence, Industrial Applications, Technology Commercialization

CHAIRS

Prof. Anselmo Frizera-Neto
University Federal do Espírito Santo (Brazil)

Prof. Andrea Cusano
University di Sanio (Italy)

Th4.1 11:30–12:00
INVITED

Prof. Chang-Seok Kim
Pusan National University (Republic of Korea)

Autonomous Vehicle 4D LiDAR Sensor based on OFDR Technology

Optical Frequency-Domain Reflectometry (OFDR) technology was actively developed in the 1990s as a 1-dimensional optical fiber sensor interrogation. It has recently evolved into a 3-dimensional spatial optical imaging system, Light Detection and Ranging (LiDAR), which is being actively industrialized in the 2020s. The next generation LiDAR with Frequency Modulation Continuous Wave (FMCW) technology, which is similar to OFDR, is expected to be crucially utilized as the eyes of autonomous vehicles, compared to the conventional time of flight (TOF) LiDAR which is based on Optical Time-Domain Reflectometry (OTDR). It has a few irreplaceable advantages of implementing 4-dimensional optical imaging that adds the velocity information of the target, having a higher signal-to-noise ratio, and being resistant to adverse weather environments on real road conditions.

Th4.2 12:00–12:15

In situ ppb-level dissolved gas detection with micro-gas-cavity based fiber photoacoustic spectrometer

Jun Ma*[a,b], Haojie Liu[a,b], Enbo Fan[a,b], Bai-Ou Guan[a,b]; [a]Guangdong Provincial Key Laboratory of Optical Fiber Sensing and Communications, Institute of Photonics Technology, Jinan University, Guangzhou 510632, China; [b]College of Physics & Optoelectronic Engineering, Jinan University, Guangzhou 510632, China.*jun.ma@jnu.edu.cn

A miniature fiber-based photoacoustic sensor capable of in situ, fast and sensitive detection of dissolved gas is developed by integrating the gas cell, gas-liquid separation membrane and detector into a fiber-tip micro-gas-cavity. The gas-liquid interface of the cavity directly separates the dissolved gas from liquid and detects the photoacoustic waves emitted by the excited gas molecules with fiber-optic interferometry. The sensor exhibits a gas detection limit of 500 ppb and a response time of less than 10 s, capable of continuously monitoring the released CO2 concentration for normal and cancer cells at different glucose levels.

Th4.3 12:15–12:30

Palladium/hafnium-coated pi-FBGs: a path to wavelength-encoded, zero-point referenced, linearized, and temperature-decoupled hydrogen sensing

Fabian Buchfellner*[a], Qiang Bian[a], Alexander Roehrl[a], Fan Zhang[b], Minghong Yang[b], Alexander W. Koch[c], Johannes Roths[a]; [a]Photonics Lab, Munich University of Applied Sciences, Munich 80335, Germany; [b]National 6 Engineering Lab for Fiber Optic Sensing Technology, Wuhan University of Technology, Wuhan 7 430070, China; [c]Institute for Measurement Systems and Sensor Technology; Technical University of 8 Munich, Munich 80333, Germany.*fabian.buchfellner0@hm.edu

This study reports, to best of the author's knowledge, on the first wavelength-encoded, palladium/hafnium (Pd:Hf)-coated grating hydrogen sensor with full zero-point reference, signal linearization, and temperature/hydrogen decoupling. Decoupling was enabled by a partially coated pi-shifted fiber Bragg grating sensor architecture, linearization by iterative matrix processing, and zero-point referencing by a comprehensive sensor calibration procedure, allowing to resolve 100 ppm (H2) with temperature read-out uncertainties <0.6°C. The findings show a higher hydrogen sensitivity of Pd:Hf compared to Pd:Ni. This study builds a promising path for field deployments.

Th4.4 12:30–12:45 ***Shock wave overpressure history mapping using high-resolution distributed acoustic sensing***

A. Masoudi*[a], T. Lee[a], M. Beresnaa, R. Critchley[b],G. Brambilla[a], J. Denny[c]; [a]Optoelectronics Research Centre (ORC), University of Southampton, Southampton, UK, SO17 1BJ; [b]Cranfield Forensic Institute, Cranfield University, College Rd, Wharley, Bedford, UK, MK43 0AL; [c]School of Engineering, University of Southampton, Southampton, UK, SO17 1BJ.*a.masoudi@soton.ac.uk

This study explored the use of high-resolution distributed acoustic sensing (HR-DAS) for measuring blast wave overpressures, addressing the limitations of conventional pressure transducers. Shock tube experiments were conducted to evaluate HR-DAS performance in capturing side-on blast overpressures, comparing its strain measurements with reference piezoelectric pressure transducers. The study examined the effects of sensing fibre orientation and mounting methods on sensor sensitivity. Results showed that HR-DAS strain histories aligned well with conventional pressure measurements. The findings demonstrate the feasibility of HR-DAS for blast wave sensing, highlighting its potential for further development and broader applications.

Th4.5 12:45–13:00 ***Humidity response analysis of optical fibers with hygroscopic coatings based on Lamé's equations***

Xin Lu*, Marcus Schukar; Bundesanstalt für Materialforschung und -prüfung (BAM), Unter den Eichen 87, 12205 Berlin, Germany.*xin.lu@bam.de

Optical fibers with hygroscopic coatings are widely used for humidity sensing, where the coating expands upon absorbing water, inducing strain in the fiber. This strain is then used to determine humidity. However, previous studies have oversimplified the strain generation process. A comprehensive three-dimensional model of the mechanical interaction between the coating and the fiber is built based on Lamé's equations. An analytical expression for the induced strain is derived. The proposed model predicts larger humidity-induced strain compared to the reported ones, given the same Young's modulus or coefficient of humidity expansion for the coating. Interestingly, the effect of coating thickness on strain response are quite similar for both methods. Experimental validation using fibers with a polyimide coating shows strong agreement with the theoretical predictions.

Th5 Session ***Interferometric/Distributed Sensors***

14:30–16:00

CHAIRS

Prof. Marc Wulpart
University de Mons (Belgium)

Prof. Yosuke Tanaka
Tokyo University of Agriculture and Technology (Japan)

Th5.1 14:30–15:00 **Dr. Giuseppe Marra**
INVITED National Physical Laboratory (United Kingdom)

Science with Seafloor Cables

Are we at the beginning of a new ear for Earth monitoring? Despite continuing advances in monitoring capability on land and from space, the bottom of the oceans remains largely unmonitored to this day. However, by turning the huge web of seafloor optical cables into environmental sensors, we can now start filling the huge data gap from the bottom of ocean. We'll show how ultra-precise optical measurements over 1000s of km of seafloor cables can provide invaluable data to advance research in a number of science areas, including seismology, oceanography and climate change, with potential applications in early warning systems.

Th5.2 15:00–15:15 ***Ultra-miniature optical fiber accelerometer Based on a 3D microprinted proof mass-integrated Fabry-Pérot micro-interferometer***

Peng Wang[a], Taige Li[a], Shangming Liu[a], Xin Cheng[a], Hwa-Yaw Tam[a], and A. Ping Zhang[a,b]*; [a]Photonics Research Institute, Department of Electrical and Electronic Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong SAR, China. [b]State Key Laboratory of Ultraprecision Machining Technology, The Hong Kong Polytechnic University, Kowloon, Hong Kong SAR, China. *azhang@polyu.edu.hk

We present an ultraminiature optical fiber accelerometer based on a micrometer-scale fiber-top Fabry-Pérot (FP) microinterferometer. An in-situ 3D microprinting technology is applied to directly print a proof mass-integrated FP microinterferometer on the end face of a single-mode optical fiber. The acceleration-induced change in the cavity length of the FP microinterferometer is demodulated by a laser interferometric readout scheme. Experimental results revealed that such an ultraminiature optical fiber optomechanical accelerometer can achieve not only a wide bandwidth with a flat frequency response of up to 10 kHz but also a low limit of detection, i.e., a noise-equivalent acceleration of 145.05 μg/√Hz.

Th5.3 15:15–15:30 ***Self-Integrated Auxiliary Interferometer for Nonlinearity Compensation in Optical Frequency Domain Reflectometry***

Salah Harb[a], Linqing Luo[a], and Gang Huang*[a] ;[a]Lawrence Berkeley National Laboratory, 1 Cyclotron Rd, Berkeley, USA.*ghuang@lbl.gov

An improved self-integrated auxiliary interferometer is proposed for efficient nonlinearity compensation in optical frequency-domain reflectometry (OFDR). By integrating auxiliary functionality directly into the OFDR trace via intentional beat signals, the system simplifies hardware, reduces costs, and minimizes acquisition time. Validated through simulations and experiments on 15 m and 100 m fibers, it effectively compensates nonlinear tuning and achieves high-resolution distributed temperature sensing, offering a cost-efficient advancement for fiber-optic sensing.

Th5.4 15:30–15:45 ***Distributed electric field measurements along a hollow-core fiber by localizing a trapped charged particle with sub-mm spatial resolution using coherent optical frequency domain reflectometry***

J. Freitag*[a], P. Schmidt[a,c], M. Borandegi[a], T. Redwig[a], and B. Schmauss[a,b,c]; [a]Institute of Microwaves and Photonics, Friedrich-Alexander-Universität Erlangen-Nürnberg, 91058 Erlangen, Germany; [b]Max Planck Institute for the Science of Light, 91058 Erlangen, Germany; [c]Graduate School in Advanced Optical Technologies, 91058 Erlangen, Germany.*jasper.freitag@fau.de

Fiber optic sensors can measure electric fields with high sensitivity while providing inherent immunity to electromagnetic interference and low disturbance to the measured field. In this work, we use a charged microparticle optically trapped inside a hollow-core fiber (HCF) as a field probe by monitoring the particle displacement induced by an electric field. To enable electric field measurements with absolute and precise position readouts, the flying particle was localized using coherent frequency domain reflectometry (COFDR). By combining the optical trapping and the COFDR setup, we have demonstrated distributed electric field measurements along the HCF with a linear sensor response up to 10 kV/m and sub-mm spatial resolution.

Th5.5 15:45–16:00 ***Measuring tip deflection in multicore fiber optic probes based on fiber segment interferometry***

Christoph Hememling, Valeriya Cherkasova, Thomas Frohlich, Thomas Kissinger; Institute for Process Measurement and Sensor Technology, Technische Universitat Ilmenau, PF 10 05 65, 98684 Ilmenau, Germany

A multicore fiber (MCF) tactile sensor with the ability to measure its tip displacement in two lateral directions is presented. Fiber Segment Interferometry (FSI) is used to measure the differential strain between opposing cores of the MCF sensor. The all-fiber sensor is very simple to construct, using only the fiber-end Fresnel reflections of MCF sections to provide the evaluated signals. The sensor was characterized through comparison with an external interferometric reference measurement. Investigations were carried out on sensor lengths of 5 mm, 10 mm, and 15 mm, demonstrating lateral tip displacement resolutions below 1 nm$\sqrt{\text{Hz}}$ at a data rate of 5 kHz.

Th-6 Poster Session III
16h30–18h00 ***Biochemical/Environment/Physical***

Th6.1 16:00–18:00 ***Capillary-based optical fiber sensor for turbidity measurement***

Evelyn Vanegas-Tenezaca[a,*], Marko Galarza[a], Romain Dauliat[b], Raphael Jamier[b], Philippe Roy[b], Adolfo Coboc, Manuel Lopez-Amo[a]; [a]Public University of Navarra, 31006 Pamplona, Spain. Electrical, Electronic and Communication Engineering Dept.; [b]Fiber Photonics Department, UMR CNRS/ University of Limoges 7252, 123 Avenue Albert Thomas, 87060 Limoges cedex, France; [c]"Grupo de Ingeniería fotónica", Avenida Los Castros s/n. Edificio de I+D+i de Telecomunicación. 39005 Santander, Cantabria, Spain. *evelyndayanara.vanegas@unavarra.es

This study introduces a novel capillary-based optical fiber sensor for turbidity measurement, utilising light reflection in its cladding. The sensor's structure has been optimised to facilitate enhanced interaction with turbid water, thereby enabling precise turbidity measurement. A three-layer neural network was used to analyse the reflected spectrum, with the results achieving a high degree of accuracy, with a maximum error of 5.21% NTU. This innovation has significant potential for enhancing water quality monitoring systems and could be utilised in a range of environmental applications.

Th6.2 16:00–18:00 ***Advanced optical fiber sensors for measuring seawater salinity and pressure***

Junhao Jing[1,2], Wanhuan Zhou[1,2,*]; [1]State Key Laboratory of Internet of Things for Smart City & Department of Civil and Environmental Engineering, University of Macau, Macau SAR, China; [2]Center for Ocean Research in Hong Kong and Macao (CORE), Hong Kong SAR, People's Republic of China.

Measuring ocean salinity and pressure is essential for understanding marine changes and climate prediction. This study presents two advanced optical fiber sensors for marine applications. The first sensor is a surface plasmon resonance (SPR) reflection probe using plastic optical fiber to measure seawater salinity, achieving sensitivities of 2321.42 nm/RIU for gold and 2640 nm/RIU for silver coatings. The second sensor is a fiber Bragg grating (FBG)-based pressure sensor, utilizing a coupling technique between elastic diaphragm and FBG. It shows a sensitivity of 19.65 pm/kPa within a pressure range of 0 to 300 kPa. Both sensors demonstrate excellent performance, providing advanced tools for marine environmental monitoring.

Th6.3 16:00–18:00 ***Evaluation of overhead cable sag using distributed acoustic sensing***

Tatsuya Okamoto*, Daisuke Iida, Kunihiro Toge; NTT Access Network Service Systems Laboratories, 1-7-1 Hanabatake, Tsukuba, Ibaraki, Japan 305–0805.*tatsuya.okamoto@ntt.com

We propose an evaluation method for overhead cable sag that utilizes distributed acoustic sensing to draw a catenary curve. Spatiotemporal analysis for dynamic strain distribution locates a single cable span from successive cable spans and reveals the strain propagation speed along a single cable span through the two-dimensional Fourier transform. The propagation speed then characterizes the catenary curve.

Th6.4 16:00–18:00 ***Remote power over fiber electro-mechanical modulation for enabling hybrid sensor networks***

Armando Rodriguez[a,b*], Manuel Lopez-Amoa[b], Mikel Bravo[a,b,c]; [a]Dpt. of Electrical Electronic and Communication Engineering, Public University of Navarra, 31006 Pamplona, Spain; [b]Institute of Smart Cities (ISC), Public University of Navarra, 31006 Pamplona, Spain; [c]Menditech, Sensores de Fibra Óptica, S.L., C/ Tajonar 22, -1, 31006 Pamplona, Spain. *armando.rodriguez@unavarra.es

This work presents a power-efficient solution based on Power over Fiber technology that combines and enables the use of electronic devices in fiber optic networks. The optical carrier is modulated via a microelectromechanical variable optical attenuator, using the processed sensor data, which is encoded in a frequency shift keying technique. To illustrate the concept, a 50-km remote environmental station is powered by energy harvesting techniques to provide the requisite power, and a low-power microcontroller encodes the data from electronic sensors. The data was successfully retrieved, achieving data rates of up to 1.5 kbps.

Th6.5 16:00–18:00 ***Indoor comfort monitoring in buildings using distributed fiber optic sensors***

R. Ruiz-Lombera*, M. Castiñeirasa, J. Ascorbe, T. Grandal; Smart Systems and Smart Manufacturing department, Centro Tecnológico AIMEN. C/ Relva, 27 A, 36410 O Porriño, Pontevedra, Spain.*ruben.ruiz@aimen.es

A novel integration of a monitoring solution for indoor comfort control and modern building management based on fiber optic sensors (FOS) is presented in this paper. These sensors effectively measure both temperature and relative humidity, using commercial fiber temperature cables, and a specially developed polyimide-coated fiber sensors ensuring an increased response to environmental humidity changes. The study highlights the ability of the developed sensors to deliver distributed, real-time environmental monitoring across large areas, offering precise insights into building conditions to advance sustainable practices.

Th6.6 16:00–18:00 ***Fiber-optic flammable vapor sensor based on a porous cholesteric liquid crystal film***

Soyeon Ahn[1], Na Hyeon Hwang[1], Min Su Kim[1], Ji Su Kim[1], Byeong Kwon Choi[2], Sung Yoon Cho[1], Jaehyun Yoo[1], Na-Hyun Bak[1], Moon-Deock Kim[1,3], Jong Hyun Kim[1,3], Min Yong Jeon[1,3,*]; [1]Dept. of Physics, Chungnam National University, Deajeon, 34134, Korea; [2]Siemens Electronic Design Automation (Korea) LLC, Seongnam-si, Gyeonggi-do, 13524, Korea; [3]Institute of Quantum Systems, Chungnam National University, Daejeon, 34134, Korea

In this study, we present an all-fiber sensor based on porous cholesteric liquid crystal film (CLCF) coated on the cross-section of an optical fiber ferrule for real-time monitoring of flammable vapors in industrial environments. Reflection band shifts according to the concentration of gases were measured using a broadband wavelength-swept laser, and the sensitivity were 3.19 pm/ppm, 4.88 pm/ppm, and 6.61 pm/ppm were obtained for acetone, toluene, and benzene vapors, respectively, with benzene vapor showing the highest sensitivity. Compared to nonporous CLCFs, the porous CLCF showed six times higher sensitivity. This sensor, which operates passively without a battery, is immune to electromagnetic interference, suggesting its potential as a reliable sensor.

Th6.7 16:00–18:00 ***Spectral analysis of type III femtosecond fiber Bragg gratings at high temperatures***

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Fiber Bragg gratings are key components for optical fiber sensing applications in harsh environments. This study investigates the spectral response of type III fiber Bragg gratings, fabricated using femtosecond lasers and the point-by-point technique, at very high temperatures (800°C-1200°C). During a 30-minute isochronal annealing process, we observed significant degradation in the reflected peak amplitude and a pronounced wavelength shift (red shift) at temperatures above 1125°C. These changes in wavelength could be explained by a structural relaxation in the glass, occurring above the glass transition temperature. These findings provide valuable insights into the physical transformations in type III FBGs under extreme thermal conditions, informing their potential for high-temperature sensing applications.

Th6.8 16:00–18:00 ***Optical fiber sensor based on lossy mode resonance for high sensitive temperature detection***

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A high-sensitive optical fiber temperature sensor based on lossy mode resonance (LMR) was demonstrated. By constructing a composite film of SnO2/PDMS with appropriate thickness, the sensor achieved a high temperature sensitivity of -1.1883 nm/°C with a fast response time of 109 ms, and maintained a high linearity over a wide temperature measurement range from 10 °C to 90 °C.

Th6.9 16:00–18:00 ***A Polarization switching and Faraday rotator mirror hybrid method for ultra low polarization fading noise in optical fiber hydrophone***

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We present a polarization switching(PS) and faraday rotator mirror (FRM)hybrid method to comprehensively suppress polarization fading induced noise in optical fiber hydrophones. Compared to the widely used FRM method, the introduction of PS brings an additional 10.5 dB phase noise reduction, which can significantly reduce the minimum measurable underwater signal.

Th6.10 16:00–18:00 ***Intensity-based refractive index sensor using sliced fiber Bragg grating***

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A refractive index sensor was designed using a novel approach to sensing based on a cleaved standard fiber Bragg grating (FBG) at the grating region, which enables the FBG to interact with its surrounding environment. The sliced-FBG (SFBG) exhibits a variable phase shift in the reflection response due to the length of the last grating's pitch, which differs from the rest. At the SFBG, the signal is the result of interference between the reflected wave from the grating and the transmitted spectrum returned due to Fresnel reflection at the final pitch, and the intensity of this signal depends on the refractive index of the surrounding medium

Th6.11 16:00–18:00 ***Dynamic strain measurement at high frequencies by using portable fiber Bragg grating (FBG) interrogator***

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In this work, we demonstrate the interrogation of fiber Bragg gratings (FBGs) for strain measurement of a metallic object by using 4- channel optical interrogator with sampling rates of 250 kSa/s per channel. The interrogator, which is packaged in a portable unit, applies a real-time active phase demodulation scheme based on multitone mixing on the signal coming from a fiber-optic Sagnac interferometer. The measurements from our interrogator show excellent agreement when compared with strain gauge-based sensors serving as reference system, and a dynamic strain resolution below 10 nε/√Hz.

Th6.12 16:00–18:00 ***Resilient DFOS placement strategy for power grid monitoring: integrating fiber and power network dependencies***

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We propose a novel Distributed Fiber Optic Sensing (DFOS) placement strategy tailored to the evolving needs of modern power grids, where fiber cables serve dual purposes: communication and real-time sensing. Our approach integrates a heuristic algorithm, PURE (Power Source-aware Route Exploration), with Integer Linear Programming (ILP) to optimize DFOS placement while addressing power supply constraints. The strategy ensures resilient monitoring across diverse grid scenarios by prioritizing observability during outages and leveraging advancements in fiber infrastructure deployment. Case studies demonstrate the effectiveness of our methodology in maintaining power grid resilience while minimizing deployment costs.

Th6.13 16:00–18:00 ***Intermittent still image monitoring system operated by weak powerover-fiber from an unused port of a PON splitter***

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We propose a still image monitoring system powered by a weak optical power supply sourced from an unused port of a PON splitter. An experimental setup was constructed to evaluate fundamental characteristics, including charging time and power consumption. Results show that the proposed system can transmit a still image every 13.4 h using a power-over-fiber of -10.8dBm.

Th6.14 16:00–18:00 ***DFBG-based shape sensor for large-curvature reconstruction***

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We fabricated a 3D shape sensor based on a wavelength-division multiplexed (WDM) and space-division multiplexing (SDM) dense fiber Bragg grating (DFBG) array with 100 FBGs in a multicore optical fiber (MCF). An overlapping spectrum separation (OSS) algorithm was proposed and applied to long measurement range and large-curvature 3D shape sensing. Shape reconstruction was successfully achieved for a length of 1994.094 m and a maximum curvature of 250 m^{-1}, with a maximum relative error of only 3.209%. This sensor shows great potential for applications in the medical field.

Th6.15 16:00–18:00 ***Optical fiber laser sensor for torsion measurement using a three-core fiber and a nanocrystals-based reflector***

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This study presents a novel and highly sensitive torsion sensor based on a multicore fiber (MCF) inside a Sagnac interferometer, which acts both as a mirror and a sensor head of a fiber ring laser. This laser sensor configuration also incorporates a distributed reflector consisting of an optical fiber segment doped with $ZnGa_2O_4$ nanocrystals, enhancing the overall performance. The sensor demonstrates high sensitivity to torsion across a range of 0° to 150°. The phase analysis in the 0°-50° range achieves a sensitivity of 0.08 rad/º. A Machine Learning Integration, with a function-fitting neural network, shows a detection limit of 0.06°.

Th6.16 16:00–18:00 ***Determining insertion depth of silica optical fiber-integrated cochlear implant electrode array using optical frequency domain reflectometry***

Jingxian Cui[a,*], Chern Yang Leong[a], Nick Pawsey[b], Linyue Lu[a], Lin Htein[a], Chao Lu[a], Denny Oetomo[d], Stephen O'Leary[c], Hwa-Yaw Tam[a]; [a]Photonics Research Institute, Department of Electrical and Electronic Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong SAR; [b]Cochlear Limited, University Avenue, Macquarie University, Sydney, NSW 2109, Australia; [c]Department of Otolaryngology, University of Melbourne and the Royal Victorian Eye and Ear Hospital, Victoria 3002, Australia; [d]Department of Mechanical Engineering, University of Melbourne, Parkville, Victoria 3010, Australia

Cochlear implantation surgery is currently the only effective treatment for restoring hearing in individuals with severe to profound sensorineural hearing loss. This study examines the integration of three types of silica optical fibers – commercial 50-µm single-mode fiber, customized 70-µm eight-shaped fiber, and customized 80-µm six-hole fiber – into straight cochlear implant electrode arrays (EAs) to evaluate their impact on insertion force and stiffness. The results indicate that EAs with integrated fibers measuring 50 µm in diameter have comparable rigidity to those without fibers, up to an insertion depth of about 23 mm in the 25-mm long EAs. Additionally, an optical frequency domain reflectometry sensing system, utilizing 50-µm single-mode fiber, is employed to facilitate precise real-time positioning of the EA during insertion. Results show that the proposed innovative sensing solutions for cochlear implantation have great potential to enhance surgical precision, improve outcomes, and reduce complications in cochlear implant procedures.

Th6.17 16:00–18:00 ***Measurement of curvilinearly varying strain using a Brillouin-gain spectrum-based method with a multiline strain model***

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We incorporated a multiline strain model (in which the strain is represented by several straight lines) into the neural network (NN)-assisted Brillouin gain spectrum (BGS)-based method. This method trained the NN using the GMOD pattern, which was calculated from the model. The measurement error was investigated for a curvilinearly varying strain using numerical simulations. We observed that as the number of straight lines in the GMOD pattern increased, the error initially decreased and then increased. Furthermore, curvilinearly varying strains were measured using the NN trained using patterns mixed with GMOD patterns calculated from the model with various numbers of straight lines. The maximum error obtained using the mixed patterns was approximately equal to or less than the minimum maximum error of the measurements with the individual multiline strain models. The errors obtained when the BGS observation section (sz) was 2 m were greater than those when sz was 1 m.

Th6.18 16:00–18:00 ***Integrated fiber-optic drug delivery system for effective anti-tumor synergistic therapy***

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Effective treatment of malignant tumors remains a thorny issue in current medicine. However, single antitumor therapy suffers from limited treatment efficacy and lack of monitoring of the treatment process. This study presents a synergistic treatment strategy utilizing fiber-optic photothermal therapy (PTT) and chemotherapy, to achieve a synergistic effect in tumor treatment. The fiber-optic system not only delivers drugs directly to the tumor site during PTT, but also provides real-time monitoring of temperature and drug release, ensuring precise and controlled therapy. We tested two chemotherapeutic drugs using the fiber-optic drug release strategy. Both successfully eradicated tumors in cancer xenograft mice models, providing a feasible approach for anti-tumor and anti-recurrence treatment. This fiber-optic synergistic treatment strategy improves the effectiveness anti-tumor therapies, which opens up new avenues for the development of multi-modal and multi-type synergistic fiber-optic therapy.

Th6.19 16:00–18:00 ***Hetero-core optical fiber-based force myography sensor***

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Force myography (FMG) is a non-invasive technique to predict hand movements and intentions from radial pressures exerted by the forearm muscles. Although previous works introduced optical fiber sensors based on microbending and fiber Bragg grating probes for such applications, the available devices exhibit cost and sensitivity constraints. Therefore, this paper proposes a wearable sensor comprising a hetero-core fiber integrated into a smart textile. The transducer is comfortably accommodated in the user's forearm with an armband, producing reliable optical loss signals as the muscular contractions bend the hetero-core section. Furthermore, we investigated the sensor's ability to discriminate four typical gestures for human-computer interfaces, achieving reliable single-channel performance by assessing the transient and stationary information of FMG waveforms. Such promising results motivate further applications in rehabilitation and human-robot interaction.

Th6.20 16:00–18:00 ***Polarization diversity detection based wavelength scanning coherent optical time domain reflectometer and its application for bus monitoring***

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Although wavelength scanning coherent optical time-domain reflectometry (WS-COTDR) system is immune to fading effect, it suffers from occasional and localized large errors caused by the false peak in the correlation spectrum due to the large signal generated in the random interference of the backscattered light. Polarization diversity detection is applied to a standard WS-COTDR system to suppress large measurement errors. In this way, the orthogonally polarized components of backscattered light can be obtained and processed separately. Due to the birefringence of the sensing fiber, the components experience different interference processes, so the average of their correlation spectrum can suppress the false peaks and finally reduce the occurrence of larger errors. The effectiveness of the proposed method is validated in laboratory for monitoring of sinusoidal vibrations and in field for tracking the bus movement via a dark fiber.

Th6.21 16:00–18:00 ***Fault classification in electric motors using feature selection on vibration data from fiber Bragg grating accelerometers: a comparison of MLP and KAN networks***

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This work proposes a fault classification method for different fault types across distinct motor speeds using vibration data from two Fiber Bragg Grating (FBG) accelerometers. Features from the time, frequency, and time-frequency domains are evaluated using the overlapping coefficient between class histograms for each feature, combined with Principal Component Analysis (PCA). Supervised classifiers, including a Multilayer Perceptron (MLP) and the novel Kolmogorov-Arnold Network (KAN), are employed, with the KAN used to enhance interpretability and develop a symbolic model for the features. The results demonstrate that 99% accuracy was achievable for both MLP and KAN neural networks. The proposed methods offer direct feature selection, providing insight into the most relevant features and combining them to effectively reduce dimensionality. The results obtained with the KAN are promising; its symbolic model achieves 99% accuracy using only sets of well-known functions, while the network model reaches accuracy comparable to the MLP but with fewer parameters.

Th6.22 16:00–18:00 ***Direct electronical readout of surface plasmon resonance biosensor enabled by on-fiber Graphene/PMMA photodetector***

Chao Shen[a,b], Junhua Huang[a,b], Shiqi Hu[a,b,c], Yaofei Chen[a,b], Gui-shi Liu[a,b], Lei Chen[a,b], Zhe Chen[a,b], Yunhan Luo*[a,b]; [a]Department of Optoelectronic Engineering, College of Physics and Optoelectronic Engineering, Jinan University, Guangzhou, 510632, PR China; [b]Guangdong Provincial Key Laboratory of Optical Fiber Sensing and Communications, Jinan University, Guangzhou, 510632, PR China ; [c]The Affiliated Guangdong Second Provincial General Hospital of Jinan University, Guangzhou 510632, P.R. China. *yunhanluo@163.com

Surface plasmon resonance (SPR) optical fiber sensors are appealing for biomolecular detection due to their inherent characteristics such as flexibility, real-time performance, and high sensitivity. However, the majority of traditional SPR optical fiber sensors utilize spectrometers for optical readout, which leads to a relatively bulky overall size of the sensing system. Herein, we present the first optical fiber device capable of conducting sensitive SPR measurements and providing direct electronical readout. This has been achieved by integrating a hyperbolic-metamaterial SPR (HMM-SPR) sensor with an on-fiber graphene/PMMA photodetector (oFGPD). More significantly, we have incorporated an SPR sensor based on a side-polished fiber (SPF) into the oFGPD, enabling an electronical readout technique for environmental refractive index (RI) SPR signals in a broad potential spectral range, from visible to near-infrared, all within a more compact device. This integration has been successfully validated in the detection of urea and glucose concentrations in artificial perspiration.

Th6.23 16:00–18:00 ***Leak detection in insulated pipe for nuclear pressure boundary monitoring using optical fiber distributed temperature sensor***

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Early leak detection and localization in insulated pipe for nuclear power plant (NPP) pressure boundary were demonstrated using optical fiber distributed temperature sensor on a small-scale NPP testbed. The results indicated that high-temperature vapor leaks in insulated pipe can be rapidly detected by real-time monitoring of temperature variations along the fiber, which is wrapped in a helical pattern around the pipeline within the insulation material.

Th6.24 16:00–18:00 ***Hydrogen sensing performance of partially Pd90:Ni10-coated pi-FBGs in nitrogen and air backgrounds***

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A pi-FBG sensor, featuring an 80 µm cladding diameter optical fiber with an 80 nm partially Pd90:Ni10 coating, was tested for hydrogen sensing in nitrogen and air backgrounds. The sensor's response in air was reduced by nearly 75% compared to its hydrogen response in pure nitrogen. Heat generation during hydrogen sorption in air was detected and quantified using an additional uncoated temperature pi-FBG sensor. Additionally, the sensor's baseline signal was found to vary depending on the carrier gas used. These observations underscore the importance of accounting for the effects of different background gases during the sensor calibration process.

Th6.25 16:00–18:00 ***Hyperbolic-metamaterial-based optical fiber SPR sensor enhanced by a smart hydrogel for perspiration pH measurements***

Ying Chen[a,b], Shiqi Hu[a,b,c], Yaofei Chen[a,b], Gui-shi Liu[a,b], Lei Chen[a,b,*], Zhe Chen[a,b,*], Yunhan Luo[a,b,*]; [a]Department of Optoelectronic Engineering, College of Physics and Optoelectronic Engineering, Jinan University, Guangzhou, 510632, P.R. China; [b]Guangdong Provincial Key Laboratory of Optical Fiber Sensing and Communications, Jinan University, Guangzhou, 510632, P.R. China; [c]The Affiliated Guangdong Second Provincial General Hospital of Jinan University, Guangzhou 510632, P.R. China *yunhanluo@163.com; thzhechen@163.com; chenlei@jnu.edu.cn, *yunhanluo@163.com; thzhechen@163.com; chenlei@jnu.edu.cn

An optical fiber surface plasmon resonance (SPR) sensor, leveraging hyperbolic metamaterials (HMMs) and pH-sensitive hydrogels, has been devised for pH detection in perspiration. Dispersion-tunable HMMs enable the sensor to transcend the inherent structural constraints of an optical fiber and enhance its refractive index (RI) sensitivity. pH-sensitive hydrogels exhibit diverse swelling behaviors due to varying ionization degrees of carboxyl groups under different solution pH conditions, leading to a notable RI change. The sensor achieves a high RI sensitivity of 6963.64 nm RIU–1 and remarkable pH sensitivity of −64.04 and −30.63 nm pH–1 within the pH ranges of 2.7 to 4.7 and 4.7 to 7.5, respectively. Compared to the sensitivity of three other constituents in perspiration, namely, urea, sodium chloride, and glucose, the sensor demonstrates exceptional pH selectivity. Additionally, it maintains good stability during operation and after prolonged storage. It is believed that the sensor has potential in health monitoring, medical diagnosis, disease treatment, etc.

Th6.26 16:00–18:00 ***Wind-resistant fault location method for aerial cables using speaker-assisted distributed vibration sensing***

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We propose a method for aerial cable position identification that combines distributed vibration sensing (DVS) with acoustic excitation. By employing targeted vibrations transmitted through direct contact between a speaker and the cable and utilizing frequency-selective detection, this approach effectively mitigates wind-induced noise. Field trials demonstrated successful position identification even under windy conditions, highlighting the method's potential to significantly enhance the efficiency and reliability of network maintenance operations.

Th6.27 16:00–18:00 ***FBG touch sensors in a social robot: Toward natural behaviors controlled by physical human-robot Interactions***

Elizabeth Sanchez R[a], María Gaitán-Padilla[a], Vinicius Mageste Coimbra[a], Maria José Pontes[a], Marcelo Eduardo Vieira Segatto[a], Marcela Munera[b], Carlos A. Cifuentes[b], Camilo A. R. Diaz[a,*]; [a]Telecommunications Laboratory (LabTel), Electrical Engineering Department, Federal University of Espírito Santo, Vitoria, Brazil; [b]Bristol Robotics Laboratory, University of the West of England, Bristol, UK.

Social assistive robots (SARs) aim to improve users' quality of life by fostering continuous and natural human-robot interactions (HRIs). TThe robot's ability to perceive and respond to user actions is crucial for effective interactions, with sensors playing a key role in adapting to users' dynamic needs, especially in therapeutic contexts. This work presents the development and initial validation of a Fiber Bragg Grating (FBG)-based sensor for touch detection in the hand of a SAR, aimed at maintaining HRIs during therapy. The proposed system involves the integration of FBG sensors into the robot's hand, enabling precise detection of the touch area. A convolutional neural network (CNN) was employed to classify the touch data, demonstrating performance in identifying contact areas across the hand's surface. The sensor's robustness and adaptability to the robot's instrumentation were also evaluated, highlighting its potential to operate reliably in therapeutic environments. This generates future research into interaction modalities, such as multi-point contact detection and adaptive interaction responses sensed with optical fiber-based technology.

Th6.28 16:00–18:00 ***Unveiling simultaneous detection and identification of different forms of amyloid-β peptides in Alzheimer's disease via multi-channel TFBGSPR biosensor***

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Despite numerous clinical trials and FDA approved drugs for Alzheimer's disease (AD) treatment, a real cure doesn't exist yet. An early and accurate diagnosis results essential before symptoms arise. Over the past few years, several types of biosensors have been developed for detecting AD biomarkers, such as Amyloid-β (Aβ) peptides, total and hyperphosphorylated Tau protein. Here, we describe the performances of a label-free plasmonic optical fiber sensing platform, integrated with a custom multi-channel microfluidic system, for parallel detection of different forms of Aβ42 peptides (i.e., monomers and oligomers) in a standard saline buffer and in mouse cerebrospinal fluid. By coupling surface plasmon resonances with highly tilted fiber Bragg grating, we obtained a high-precision interrogation and an ultrasensitive analytes detection, whose limit was found in the order of pg/ml. By studying binding kinetics, it was possible to discriminate Aβ42 monomers and oligomers, thus making our device very promising for clinical diagnostics.

Th6.29 16:00–18:00 ***Pre-eclampsia diagnosis on clinical samples using microfiber Bragg grating-assisted point-of-care biosensor***

Shifang Cao[a,b], Ruiping Chen[a], Rukmani Singh[c,*], Claudia Borri[c], Shadab Dabagh[c], Qiaochu Yang[b], Xin He[a], Yang Ran[b], Bai-Ou Guan[b], Francesco Chiavaioli[c]; [a]The First Clinical Medical College, Jinan University, 510630 Guangzhou, China; [b]Institute of Photonics Technology, Jinan University, 510632 Guangzhou, China; [c]National Research Council of Italy (CNR), Institute of Applied Physics "Nello Carrara", 50019 Sesto Fiorentino, Italy. *r.singh@ifac.cnr.it

Pre-eclampsia is a severe multi-organ condition of pregnancy that endangers both infants and mothers. Timely diagnosis is crucial for better results, but existing procedures are typically sluggish, need specialist equipment, and do not always guarantee the necessary degree of accuracy, reliability, and sensitivity for clinical validation. Placental growth factor (PlGF), an important biomarker for pre-eclampsia, diminishes in pregnant women. The proposed microfiber Bragg grating (μFBG)-assisted point-of-care biosensor can detect PlGF, addressing these problems. The dual FBG design on a tapered optical fiber reduces temperature variations while achieving great specificity and sensitivity. The biosensor, integrated with a microfluidic chip, requires just 10 μL of samples and attains a detection limit of 5 pg/mL in the whole serum of patients (working range of 5-120 pg/mL). This technology, with 87.5% specificity, provides a low-cost, highly efficient solution for clinical settings, ensuring early identification and treatment of pre-eclampsia and therefore enhancing maternal and newborn care.

Th6.30 16:00–18:00 ***WSe2-PDA enhanced fiber optic surface plasmon resonance bioprobe for the detection of prostate-specific antigen***

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Here, we report a WSe_2-PDA enhanced fiber optic surface plasmon resonance (FO-SPR) bioprobe for the sensitive detection of prostate-specific antigen (PSA). The bioprobe features a near-field enhanced sensing structure composed of a fiber, WSe_2 film, gold film, and polydopamine (PDA)@Wse2 film. The near-field electron coupling between the WSe_2 and gold films significantly increases the electric field intensity on the sensor surface, thereby improving the overall sensitivity. Meanwhile, the PDA film, serving as an effective antibody coupling agent, offers excellent biocompatibility and enhances the bioprobe's capacity to capture target biomolecules. Experimental results using low-concentration PSA samples demonstrate a detection limit of 0.18 ng/mL, more than one order of magnitude lower than the clinical reference value. Such a low detection limit effectively mitigates measurement errors. Owing to its label-free, low-cost, and convenient operation, this bioprobe shows great.

Th6.31 16:00–18:00 ***Vibration identification of fiber optic current sensors based on dual closed-loop feedback and VMD***

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A dual closed-loop feedback scheme is employed to divide the FOCS into two operating cycles. Current and vibration are measured separately by maintaining different sensitivities. Then, the data collected from the two cycles are decomposed using the VMD method. By comparing the time of the burst point, it is determined whether the fluctuation in the first cycle is caused by vibration, so as to avoid false tripping accidents.

Th6.32 16:00–18:00 ***Non-contact sleep atrial fibrillation monitoring using fiber optic sensors***

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This study presents a fiber optic monitoring pillow (FOMP) designed for non-contact sleep monitoring of patients with atrial fibrillation (AF). The FOMP employs fiber optic sensors to capture respiratory and cardiac waveforms, enabling the extraction of physiological parameters such as heart rate and respiratory rate. In a clinical trial involving AF patients, the FOMP successfully detected effective ballistocardiogram signals using a non-contact approach for the first time, demonstrating a high correlation with electrocardiogram data, as evidenced by a Pearson's correlation coefficient of 0.984. Additionally, the FOMP effectively identified abnormal respiration patterns indicative of sleep apnea. This non-invasive monitoring technique offers a valuable tool for the early detection and continuous assessment of cardiovascular health, underscoring its potential for integration into routine health monitoring protocols.

Th6.33 16:00–18:00 ***Abandoned objects detection on the highway based on distributed features of UWFBG array sensors***

Sheng Li[a], Yunhai Huang[b], Jinpeng Jiang[a], Fang Liu[a], Yan Yang[a], Yueming Wang[a], Yimin Xu[a], Wenbin Hu[a,*]; [a]National Engineering Research Center for Fiber Optic Sensing Technology and Networks, Wuhan University of Technology, Wuhan 430070, China; [b]School of Information Engineering, Wuhan University of Technology, Wuhan 430070, China.*wenbinhu_whut@163.com

Real-time monitoring of abandoned objects on the highway, with limitless vision and adaptability to diverse weather or lighting conditions, is essential for the Intelligent Transportation System (ITS). This paper proposes a method to identify the abandoned objects based on distributed features of ultra-weak fiber Bragg grating (UWFBG) array sensors. In the field experiment conducted in a real highway, the UWFBG array vibration sensing cables were utilized to capture vibration signals generated by the abandoned object dropped from the vehicle. The signal processing algorithm, including intensity mapping, filtering and self-developed extraction algorithm, are deployed to map and extract the signal features of abandoned objects, and the high-efficient identification and localization extracted from the massive noisy data are approached. The analysis results demonstrate that the proposed method can accurately identify abandoned objects on the highway, without any interference by poor lighting or inclement weather condition.

Th6.34 16:00–18:00 ***High-resolution optical fiber ring magnetic field sensor***

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The high-resolution measurement of magnetic field is of great significance in scientific research and production. Here we propose a high-resolution fiber ring magnetometer based on laser frequency stabilization technology. By connecting one output port to an input port of a fiber coupler with a splitting ratio of 1:99, the fiber ring resonator (FRR) generates a series of highly narrow transmission resonances. Through clever structural design, the response of the magnetostrictive material (TbDyFe cake) to the magnetic field changes is efficiently transmitted to the FRR, and the response is amplified by multi-loop wrapping. By tracking the high-Q resonant peak of the FRR based on the laser frequency stabilization technique, we realize the high magnetic field resolution of 433 pT/√Hz over 1 Hz.

Th6.35 16:00–18:00 ***A magneto-optical fibre rotary sensor for robotics***

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A novel magneto-optical rotary optical fibre sensor is demonstrated. It is used to remotely characterise a simple rotary robotic arm with an angular resolution of ~ 1°, determined by the accuracy of the arm rotation. The sensor itself can undertake continuous 360° rotation and reached a measured angular resolution of less than 0.5° when tested at rotary rates between 135 °/s and 369 °/s.

Th6.36 16:00–18:00 ***Localized surface plasmon resonance based optical fiber mercury ion sensor employing CNT/PVA nanocomposite***

Fatima Banoo, Sunil K. Khijwania; Indian Institute of Technology Guwahati, Guwahati-781039, Assam India

A novel highly sensitive and selective LSPR based U-shaped optical fiber mercury ion sensor is developed. The sensor employs carbon nanotubes and polyvinyl alcohol (CNT/PVA) nanocomposite as the sensing material. Proposed sensor exhibits a remarkably low detection limit of 0.08 ppb, high sensitivity of 0.2458 nm/ppb, linear response within the range of 0–30 ppb, offering an accurate and cost-effective solution for monitoring water quality.

Th6.37 16:00–18:00 ***GST-enhanced fiber SPR curvature sensor***

Xuhao Ji[a,b], Zhuo Ren[a,b], Nailiang Yu[a,b], Jianan Liu[a,b], Jiaxin Gao[a,b], Yu Zhang[a,b,*], Zhihai Liu[a,b,*]; [a]Key Laboratory of In-Fiber Integrated Optics, Ministry of Education, Harbin Engineering University, Harbin, 150001, P. R. China; [b]Key Laboratory of Photonic Materials and Device Physics for Oceanic Applications, Ministry of Industry and Information Technology of China, Harbin Engineering University, Harbin, 150001, P. R. China

This paper proposes a high-sensitivity surface plasmon resonance (SPR) curvature sensor based on hard polymer-clad fiber (HPCF). The sensor utilizes an HPCF coated with gold and $Ge_2Sb_2Te_5$ (GST), with a layer of polydimethylsiloxane (PDMS) as the sensing medium for curvature measurement. GST enhances the sensor's sensitivity by increasing the dielectric constant of the metal layers. The sensor exhibits high sensitivity and can identify bending direction, with sensitivities of 1.74 nm/m^{-1} for positive x-direction bending and 6.21 nm/m^{-1} for negative x-direction bending. This sensor offers a novel solution for high-sensitivity curvature measurement with a wide measurement range and directional recognition capabilities.

Th6.38 16:00–18:00 ***Fiber Bragg grating monitoring during 3D wire arc additive manufacturing process***

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Fiber Bragg grating can be used to monitor temperature, strain, ..., in harsh environments. Benefiting from this process, high temperature type III fiber Bragg grating were inscribed in Telecom optical fiber in order to monitor the manufacturing of stainless steel (316L) walls using the wire arc additive manufacturing process. In this study, walls of about 9 cm long per 2 cm width and 10 cm height was built. The gratings were placed inside steel capillaries ranging from 1 mm to 5 mm of external diameters, so as to protect the fiber from the molten metal and to keep the fiber free from any stress. This enables the measurements of only the required temperature fields. Some fibers were also fixed on the substrate to measure its deformation. During the process, temperatures up to more than 200°C were measured, for a grating located at less than 1 cm from the wall edge and deformation up to 1.2 mε at room temperature. These measurements provide new information to optimize the manufacturing of parts using wire arc additive manufacturing process.

Th6.39 16:00–18:00 ***Comparative analysis of distributed acoustic sensing and geophones for multichannel surface wave applications***

João Paulo Bazzo[a], Beatriz Brusamarello[a], Guilherme Heim Weber[a], Ulilian José Dreyer[a], Gustavo Macioski[a], Larissa Wierzynski Kulik[a], Sidnei H. C. Teixeira[b], Gilson A. Brunetto[c], Luis F. P. Melegari[c], Daniel Rodrigues Pipa[a], Cicero Martelli[a], Jean Carlos Cardozo da Silva[a]; [a]Universidade Tecnologica Federal do Paraná (UTFPR); [b]Universidade Federal do Paraná (UFPR); c CPFL Energia Brasil

This paper presents experimental results comparing the application of a Distributed Acoustic Sensing (DAS) system and geophones combined with the Multichannel Analysis of Surface Waves (MASW) technique. The tests were conducted using a 100 m-long telecommunications optical cable and 24 geophones. The excitations were performed using an 8 kg sledgehammer. The results show that the DAS system can estimate the fundamental propagation modes of seismic waves with significant similarity to those estimated by the geophones, leading to the soil classification based on the shear wave velocity profile and accurate determination of the depth of each layer. To achieve this, a signal processing technique - frequency-wavenumber (f-k) domain filtering is applied to the strain signals measured by the DAS system to convert strain into particle velocity.

Th6.40 16:00–18:00 ***Double-helix shaped optical fibers as a route for high torsion sensing***

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This work describes the development of a novel fiber optic structure composed of two wrapped silica single-mode optical fibers. This structure acts like an interferometer where light propagating in the core fiber interferes with light that has propagated in the cladding region. The structure was fabricated with a period of 3.8 mm, showing high sensitivity to torsion (≈ 0.46 rad/m), with direction discrimination. The key advantages of this technology lie in its high torsion sensitivity and its low temperature cross sensitivity (≈ 0.18(rad/m)/ºC).

Th6.41 16:00–18:00 ***A new embeddable FBG sensor system to measure and decouple moisture swelling, thermal expansion, and mechanical strain***

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This paper introduces an innovative Fiber Bragg Grating (FBG) sensor system designed to measure and decouple the simultaneous effects of temperature, humidity, and mechanical strain within a host material. The system uniquely integrates a novel theoretical framework and a specific sensor configuration to accurately isolate these parameters. The proposed sensor system consists of three FBG sensors: one dedicated to temperature measurement, a second sensitive to both temperature and humidity, and a third influenced by temperature, humidity, and strain. A theoretical framework, based on linear strain superposition and constitutive laws, is developed to separate each factor's contribution. Experimental validation, conducted under controlled hygrothermal conditions, demonstrates the system's ability to detect and decouple these effects accurately, enabling precise monitoring. The described system provides a reliable, compact, and effective solution, suitable for long-term monitoring. It further enables enhancements in predictive maintenance through improved accuracy of health and usage monitoring systems (HUMS).

Th6.42 16:00–18:00 ***Bacterial biofilm detection using a fiber optic Mach-Zehnder interferometer***

Flavio Esposito[a], Attena Rashidi[a], Adriana Sacco[b], Carmine Vitagliano[c], Federica Granata[d], Anubhav Srivastava[a], Stefania Campopiano[a], Giuseppe Coppola[d,*], Michele Giordano[c], Gennaro Di Prisco[b,*], Lucia Sansone[c,*], Agostino Iadicicco[a,*]; [a]Department of Engineering, University of Naples "Parthenope", 80143 Naples, Italy; [b]Institute for Sustainable Plant Protection (IPSP), CNR, 80055 Portici, Italy; [c]Institute for Polymers, Composites, and Biomaterials (IPCB), CNR, 80055 Portici, Italy; [d]Institute of Applied Science and Intelligent Systems (ISASI), CNR, 80128 Naples, Italy *giuseppe.coppola@cnr.it, gennaro.diprisco@cnr.it, lucia.sansone@ipcb.cnr.it, agostino.iadicicco@uniparthenope.it

In this work, we report about the detection of biofilm growth formation using fiber optic sensing technology. The optical configuration involved a fiber optic tip integrating a Mach-Zehnder interferometer (MZI). The simple and cost-effective fabricating process employs standard single-mode fiber SMF28, a splice with overlap as coupling/re-coupling element for the fiber modes, and a silver mirror enabling a reflective configuration to have a miniaturized and compact device. As a case study, the growth of bacterial biofilm of Pseudomonas alcaligenes was monitored in real-time during about 60 hours by observing the resonance wavelength shift of the MZI. The biofilm layer formation was further confirmed by Atomic Force Microscopy analysis and its thickness measured. These findings pave the way for the development of highly sensitive miniaturized probes for the detection of different types of biofilms, to be applied in a wide range of domains, from biomedical to industrial fields as well as environmental monitoring.

Th6.43 16:00–18:00 ***Outstanding sensitivity to ionizing radiation of custom optical fibers evaluated in real-time by Long Period Gratings***

Flavio Esposito[a], Andrei Stancalie[b,*], Anubhav Srivastava[a], Razvan Mihalcea[b], Ivo Bartoň[c], Daniel Negut[d], Stefania Campopiano[a], Mateusz Śmietana[e], Jan Mrázek[c,*], Agostino Iadicicco[a,*]; [a]Department of Engineering, University of Naples "Parthenope", 80143 Naples, Italy; [b]Center for Advanced Laser Technologies (CETAL), National Institute for Laser, Plasma and Radiation Physics, Magurele RO-077125, Romania; [c]Institute of Photonics and Electronics, Czech Academy of Sciences, Prague, Czech Republic; [d]"Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering, Magurele RO077125, Romania [e]Warsaw University of Technology, Institute of Microelectronics and Optoelectronics, 00-662 Warszawa, Poland; and Łukasiewicz Research Network – Institute of Microelectronics and Photonics, Department of Glass, 02-668 Warszawa, Poland. *andrei.stancalie@inflpr.ro; mrazek@ufe.cz; agostino.iadicicco@uniparthenope.it

In this work, we report on the gamma radiation sensitivity of different optical fibers, including a custom-designed scintillating fiber and commercially available models with different core compositions (Ge-doped, P-doped, and pure-silica). The sensitivity was comparatively investigated by monitoring the shift in the resonant wavelength of long period gratings (LPGs) inscribed in these fibers, which were exposed to a 1.8 kGy/h gamma dose rate until reaching a maximum absorbed dose of 36 kGy. The LPG period was selected to have the coupling with a high order cladding mode near 1550 nm. Additionally, post irradiation permanent effects were observed after the following two days. Real-time measurements highlighted a significant dependence of the response on the fiber composition, with the scintillating optical fiber demonstrating one order of magnitude higher sensitivity than other fibers. By tailoring the fiber composition and grating parameters, this study aims to develop fiber-based sensors capable of precise and reliable measurements in diverse radiation-rich settings, including nuclear reactors, space exploration, and particle accelerators.

Th6.44 16:00–18:00 ***Comparative evaluation of thiram detection by LSPR based fiber optic probes with different nanostructures***

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In this work, we present an experimental investigation of highly sensitive optical fiber sensors utilizing localized surface plasmon resonance (LSPR), achieved by depositing gold nanoparticles (NPs) and nanostars (NSs) onto uncladded silica multi-mode fiber. NSs unique optical characteristics are explored in this configuration and spherical NPs are also examined for comparison. The sensitivity to surrounding medium refractive index was equal to about 440 nm/RIU for an LSPR generated by the NS, whereas in the case of NPs it was only 130 nm/RIU. As a case study, the sensors were also employed to detect Thiram, a widely used harmful agricultural pesticide, demonstrating a broad detection range from 10 nM to 100 µM and a significant wavelength shift up to 7 nm. This study underscores the simplicity, affordability, and superior performance of NS-based optical fiber sensors, positioning them as a highly promising solution for applications in environmental monitoring, biomedical diagnostics, and chemical detection.

Th6.45 16:00–18:00 ***Seismic activity monitoring in Iceland with Fiber Bragg Grating accelerometers***

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The use of fiber optics for monitoring ground motion in seismic applications is often restricted to Distributed Acoustic Sensing. In contrast, the use of Fiber Bragg Grating technology remains relatively uncommon in seismology and studies are frequently confined to laboratory conditions. In this study, we deployed several FBG-based accelerometers during two experiments conducted in Belgium and Iceland. The accelerometers used in Iceland were buried in the ground and connected to a 512-pixel, 8-channel interrogator with 1 pm accuracy, installed on-site. These accelerometers featured a symmetrical double cantilever beam design and demonstrated sensitivities ranging from 386 pm/g to 501 pm/g. The results from the experiment in Belgium revealed that our system could detect daily variations in seismic noise caused by anthropogenic activities. Meanwhile, in Iceland, the setup successfully recorded multiple local seismic events from a nearby seismic swarm, with local moment magnitudes ranging from 0.9 to 3.0. Overall, we demonstrated that our system could provide accurate measurements, even under harsh outdoor environmental conditions during the Iceland deployment.

Th6.46 16:00–18:00 ***Ship hydrodynamic pressure field detection using distributed acoustic sensing and a submarine photoelectric composite cable***

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Ship monitoring is highly significant in the marine field, including shipping operations, ecological conservation, and fishery development. Specifically, to enhance the detection and identification capabilities of distributed acoustic sensing (DAS) for ships passing overhead and to acquire more extensive information associated with ships, the collection of multi-dimensional physical field information is imperative. Based on this requirement, the ship hydrodynamic pressure field (SHPF) model is developed. This SHPF is monitored using DAS with a submarine photoelectric composite cable.

Th6.47 16:00–18:00 ***A step towards multipoint hydrogen sensing: development of metal hydride-coated FBG hydrogen sensors***

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Hydrogen, a leading driver of zero emission fuel solutions, requires precise sensing solutions. This research focuses on the development of metal hydride-coated Fibre Bragg Grating (FBG) based hydrogen sensors, marking a significant step towards the realisation of multipoint hydrogen sensing systems – a growing demand in the industry. The performance of three FBG sensors coated with nanometre-thick tantalum, palladium, and palladium-gold hydrogen sensing metal thin films, deposited via magnetron sputtering, is presented. Among these, the novel tantalum-coated FBG exhibited the best performance, achieving a minimum detection limit of 50 ppm and and an enhanced sensitivity below 0.1% H2 levels at room temperature.

Th6.48 16:00–18:00 ***Coating of microfibrillated cellulose on plastic optical fiber***

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This paper presents the experimental development of a coating based on microfibrillated cellulose (MFC) applied to a plastic optical fiber. The primary objective is to utilize this fiber as a biosensor for detecting calcium ions and other chemical elements commonly found in industrial process residues present in effluents. The developed sensor's optical performance was evaluated through measurements of transmittance, reflectance, and absorbance. By integrating the unique properties of optical fibers with the versatility of cellulose, the proposed device demonstrates significant potential for efficient and reliable monitoring of target substances in industrial wastewater.

Th6.49 16:00–18:00 ***Ballistocardiography sensor based on polymeric optical fiber: A frequencies validation study***

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Wearable monitoring systems have represented a breakthrough in monitoring vital signs such as respiratory and heart rates. These systems can collect information from the vibrations in the chest due to blood pumping and the movements generated by breathing, known as ballistocardiography (BCG). This work presents the development of a sensor based on fiber optics, developing a sensitive area with a viscoelastic material. The sensor validation was performed with an experimental setup in which heart and breathing movements were simulated. Three combinations of respiratory and cardiac frequencies were selected to evaluate the sensor performance. The sensor's performance achieved an average success rate of 97% for pulse and 100% for respiration detection. It also demonstrated the ability to detect signal peaks at different magnitudes and frequencies. This makes the sensor attractive for further applications such as stress detection and evaluation of the response to several parameters to improve its performance.

Th6.50 16:00–18:00 ***Evaluating the performance of CT method in distributed Brillouin fiber sensing***

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We present a numerical analysis of the performance (e.g., SNR and spatial resolution) of a recently proposed computed tomography (CT) method in distributed fiber sensing (Opt. Express 29, 35067 (2021)). Compared with conventional methods, the CT method achieves an N^0.5 improvement in the SNR scaling law with respect to the number N of resolved points, at the expense of random accessibility and a few times lower spatial resolution.

Th6.51 16:00–18:00 ***A magneto-optical fibre transducer***

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A modified optical circulator with a combined permanent and tuneable electromagnet with a coupled RF Bluetooth receiver is used as a simple, low-cost magneto-optical transducer to couple generic sensor signal outputs into optical fibres. As proof of concept, a simple remote wireless smoke detector is interrogated through 2 km of optical fibre using this device. The threshold applied voltage needed in this demonstration is V = 0.35V and the measured response time t = 6 us.

Th6.52 16:00–18:00 ***Fiber Bragg grating-based sensing for dynamic strain and speech recognition***

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In this work, we report on the use of fiber Bragg grating (FBG) with post-processing techniques to enhance speech recognition quality. Our approach integrates FBGs with signal processing methods, including DC removal, band-pass filtering, and least mean square (LMS) filtering, to improve the quality of recorded speech signals. We then used open speech recognition services and the open Harvard dataset to achieve a word error rate (WER) of 26% and a Levenshtein distance (LD) of 50. These results highlight the potential of FBG-based systems for applications requiring robust speech recognition, especially in environments where traditional microphones are ineffective.

Th6.53 16:00–18:00 ***Normalized temperature sensitivity of fiber Bragg gratings inscribed under different conditions***

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In this paper we present results on the normalized temperature sensitivity of UV- and fs-induced fiber Bragg gratings in a singlemode fiber with ~4.7 mol% GeO2 and having an Ormocer coating. In the 1500-1600 nm wavelength range, the former shows an almost constant value of 6.165x10-6 K-1, whilst the fs-induced present some variation not related with the strength of the grating but probably due to induced birefringence. The average value obtained was 6.191x10-6 K-1 which is higher than the former. For the UV-induced gratings in the Corning SMF-28 fiber (3.67 mol% GeO2) the value obtained was 6.143x10-6 K-1. The achieved values are compatible with the use of Corning 7980 silica-based cladding fiber. Preliminary results also show no measurable impact of the hydrogenation process or the strength of the grating on the normalized temperature sensitivity.

Th6.54 16:00–18:00 ***Fiber Bragg grating 7-core hydrophone as an acoustic waves direction sensor***

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This study proposes an FBG 7-core membrane hydrophone capable of detecting low-frequency underwater sound waves and determining the resulting fiber bending direction. The hydrophone features a 3D-printed cylindrical shell with a latex membrane, to which the 7-core fiber is adhered at its center. Acoustic waves ranging from 50 to 400 Hz were generated using an underwater speaker, and Bragg wavelength shifts were recorded via a high-speed spectrum analyzer. Signal processing, including spectrograms, filtered wavelength shift-time representation, and Power Spectral Density analysis was applied to evaluate performance. The results revealed consistent signal patterns across cores, matching theoretical simulations and enabling bending direction determination. Experimental data confirmed that core-specific signal amplitudes align with the neutral axis orientation, and wavelength shift oscillations were used to calculate the curvature vector. The bending direction was determined to form a 64.09º angle with the reference axis. This work establishes a foundation for future three-dimensional directional determination of sound waves using Fiber Bragg Grating hydrophones.

Th6.55 16:00–18:00 ***FBG-based force sensing gripper in minimally invasive robot assisted laparoscopic surgery***

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Robot-assisted surgery (RAS) has emerged as a groundbreaking technique retaining much of the functionality of traditional open surgery in terms of visibility, flexibility and precision, whilst the minimally invasive incision adds benefits in healing time and reduced risk of complications. Force feedback plays a crucial role in ensuring surgical safety and effectiveness, as excessive or inappropriate forces can result in unwanted tissue damage, bleeding and/or poor outcome. In the work reported here, we embedded fibre Bragg grating (FBG) sensors along the length of a standard minimally invasive surgical gripper jaw to measure the strain resulting from a clamping force applied at the tip of the jaw. We have found that the FBG has sufficient sensitivity to monitor surgically relevant forces without excessive deformation. Future work will explore multi-axis strain measurements to monitor different types of force experienced by the gripper.

Th6.56 16:00–18:00 ***Logic-gated biolaser for digital biochemical sensing***

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We report a digital biosensor with the logic gate in an optical fiber microcavity. The logic gate is controlled by analyte-induced DNA conformation changes, switching laser emission through the FRET effect. Logic gates of OR and INHIBIT are demonstrated for digital biosensing with a wide threshold range, about one order of magnitude higher than fluorescence.

Th6.57 16:00–18:00 ***Temperature characterization of nanoparticles-doped fiber in the context of transmission-reflection analysis***

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We present the results of temperature characterization of Mg-Er-doped fiber up to 250°C. We investigate the cause of this nanoparticles-doped fiber sensitivity by comparing our results to single mode fiber and Erbium-doped fiber under temperature variations from 20°C to 80°C. Acrylate coating does not seem to influence fibers' temperature sensitivity, but Erbium appears to be a significant element in this study. The nanoparticles-doped fiber does not have a linear response to temperature variations and there is a drift between the increase and the decrease of the temperature. We estimate the sensitivity to be 150 nW/°C from 20°C to 100°C and 85 nW/°C from 100°C to 250°C.

Th6.58 16:00–18:00 ***Multipoint measurement of strain using FSBS induced acoustic mode resonances***

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Acoustic resonances induced by forward stimulated Brillouin scattering in an all-fiber setup are employed for performing a multiplexed, multipoint, strain sensor. We use an all-fiber ring resonator for the measurement of the acoustic vibrations induced in the fiber by means of electrostriction. The strain of the fiber is investigated through the analysis of the radio frequency spectrum of the acoustic mode resonances.

Th6.59 16:00–18:00 ***Real-time high-precision traffic flow monitoring with DAS***

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Distributed Acoustic Sensing (DAS), with its high sensitivity, long-distance monitoring capabilities, and distributed sensing features, plays a significant role in intelligent transportation systems. However, achieving real-time, accurate, and cost-effective traffic monitoring remains a challenge due to the high sensitivity required and the complex field backgrounds. This paper proposes a real-time Rotated YOLO (R-YOLO) enhanced method for high precision monitoring traffic flow with DAS, including vehicle tracking, type recognition, and moving speed estimation. By monitoring four days of railway data and two days of road data, our model achieves a tilted detection accuracy of 96.7% for traffic flow within 13 seconds per frame, while the average speed estimation error across five railway datasets is only 4.28%. These metrics outperform traditional YOLO detection methods, demonstrating the promising potential of our model for application in traffic monitoring.

Th6.60 16:00–18:00 ***Fiber Bragg grating-based optical fiber sensing system integrated with ensemble deep learning for enhanced liquid level sensing***

Siva Kumar Nagi, Amare Mulatie Dehnaw, Yao-Jen Chung, Pradeep Kumar, Zi-Gui Zhong, Peng-Chun Peng; Department of Electro-Optical Engineering, National Taipei University of Technology, Taipei 10608, Taiwan

This paper presents a novel Fiber Bragg Grating (FBG)-based optical fiber sensing system enhanced by an ensemble deep learning (EDL) model for liquid-level measurement. The system utilizes FBG sensors to improve sensitivity, accuracy, and cost-efficiency by detecting Bragg wavelength shifts caused by liquid level changes. A key challenge in sensor multiplexing is reflected signal overlap or cross-talk, which affects measurement accuracy. To address this, the proposed EDL model effectively predicts liquid levels while mitigating overlap issues. Experimental results demonstrate the EDL model's superior performance with minimal error, low testing times, and significantly enhanced detection accuracy. The model outperforms other deep learning approaches, establishing a strong linear relationship between strain sensitivity and liquid levels. This integration of FBG sensors and EDL offers a robust, precise, and cost-effective solution for liquid-level sensing, paving the way for advancements in optical sensing applications.

Th6.61 16:00–18:00 ***Humidity sensor based on MMF-CLF-MMF structure with GOEnhanced SPR effect***

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A tapered multimode coreless multimode fiber structure (MMF-TCLF-MMF) has been proposed and studied for refractive index (RI) and humidity sensing applications. A gold film was deposited on the tapered region to excite surface plasmon resonance (SPR), which serves as the sensing area. Further surface functionalization with graphene oxide (GO) enhances the SPR effect. A high sensitivity of 5448.7 nm/RIU was achieved within the RI range of 1.37-1.41. In the relative humidity range of 30%-80%, a humidity sensing sensitivity of 116 pm/%RH was achieved.

Th6.62 16:00–18:00 ***A novel plate-type fiber optic sensor for enhanced underwater detection***

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A new plate-type optical fiber sensor for underwater detection is introduced, with a sensitivity of up to -147.85 dB re rad/μPa@1Hz.

Th6.63 16:00–18:00 ***Reliable, doped hybrid xerogel-based optical fibre sensor for pH monitoring for industry***

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A new optical fibre pH sensor has been developed based on incorporating the pH indicator in a hybrid siliceous xerogel.

Th6.64 16:00–18:00 ***Optical fiber fluorescence sensor integrated into a photobioreactor***

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In this work, we integrated, via optical fibers, a simple fluorescence sensor into a small, low-cost photobioreactor. For the proper implementation, plastic optical fibers were used to excite the colloid, while the fluorescence signal was collected by another fiber and guided to a spectrometer. Real-time tests were carried out with cyanobacteria cultures, confirming the usefulness of monitoring these autofluorescence changes in the photobioreactor. This device provides a preliminary approach for the characterization and detection of cyanobacteria, demonstrating the feasibility of developing small, practical sensors through a simple fiber configuration for monitoring aquatic ecosystems.

Th6.65 16:00–18:00 ***Low-cost implementation of polarization-stable Sagnac intrusion detection system using standard networking hardware***

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We demonstrated a polarization stable intrusion detection system that is based on a Network Interface Card (NIC) and an optical Small Form-factor Pluggable (SFP) module, such that all active parts of the system are integrated in a single PC.

Th6.66 16:00–18:00 ***Bio-amplified fiber microlaser for ultrasensitive and disposable immunosensing***

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Based on telecom optical fiber, we report a bio-amplified microlaser for ultrasensitive and disposable immunosensing. A four-order-of-magnitude-enhancement in sensitivity has been demonstrated for avidin detection. Then, the biolaser is applied for cancer biomarker (PD-L1) detection, achieving a limit of detection of 3.2 pg/mL.

Th6.67 16:00–18:00 ***Distributed magnetic sensing with high precision and long distance using polarization-sensitive optical frequency domain reflectometry***

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The fiber based distributed magnetic sensing has significant research and application value in strong magnetic measurement field, such as thunderstorm warning and nuclear reaction detection. The current polarization sensitive reflectometry technology has a limit of short measurement distance and low sensitivity. We proposed a sensing method based on polarization sensitive time-gated digital optical frequency domain reflectometry (TGD-OFDR) to analyze the changes in state of polarization (SOP) before and after applying a magnetic field, for measuring the magnetic intensity. The sensing distance has been increased to 10 kilometers and the measurement error has been decreased to 5 mT.

Th6.68 16:00–18:00 *Portable SPR-based optical fibre sensing platform for detection of cortisol and escherichia coli*

Lucas Pereira[a,*], Bárbara Gonçalves[b,c], Francesco Arcadio[d], Nunzio Cennamo[d], Luigi Zeni[d], Luís Fontes[e,f], Pavel Zelenovskii[a], Carlos Marques[a,g,*]; [a]CICECO – Aveiro Institute of Materials & Physics Department, University of Aveiro, 3010-193 Aveiro, Portugal; [b]Associate Laboratory i4HB — Institute for Health and Bioeconomy, School of Sciences and Technology, NOVA University of Lisbon, 1099-085 Lisbon, Portugal; [c]Egas Moniz Center for Interdisciplinary Research (CiiEM), Egas Moniz School of Health and Science, Almada, Portugal; [d]Department of Engineering, University of Campania "L. Vanvitelli", Aversa, Italy; [e]CICECO – Aveiro Institute of Materials & Chemistry Department, University of Aveiro, 3010-193 Aveiro, Portugal; [f]LAQV-Requimte, Department of Chemistry, University of Aveiro, 3010-193 Aveiro, Portugal; [g]Department of Physics, VSB – Technical University of Ostrava, Ostrava, 70800, Czech Republic

The optical detection of analytes in aqueous solutions was the focus of this study. Polymer optical fibre D-shape sensors based on surface plasmon resonance (SPR) were employed in a portable platform to measure the levels of the stress hormone cortisol and the bacterial strain Escherichia coli. The sensors were reliable in identifying increasing cortisol levels but responded slightly worse to the Escherichia coli pathogen. The sensitivity of Escherichia coli sensors was -0.38±0.06 nm/log(CFU/mL), which is comparable to the sensitivity of cortisol sensors, which was -0.41±0.04 nm/log(ng/mL). With a cortisol limit of detection (LOD) of 1.73×10−4 pg/mL and Escherichia coli detection limit of 3.72×10−7 CFU/mL, the biosensors' LODs were lower than those found in the literature. Atomic Force Microscopy (AFM) revealed tiny topographical profile variations of 2.0–3.4 nm, which is comparable to the thickness of the used antibodies and indicates that they were deposited parallel to the gold surface. Future research should focus on techniques that could guarantee antibody verticality.

Th6.69 16:00–18:00 *Flexible wearable optical sensor based on a balloon-like interferometer to breathing monitoring*

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A flexible wearable sensor utilizing a balloon-shaped interferometer structure, created from a bent standard single-mode fiber and a 3D-printed piece, was introduced and shown for respiratory monitoring. The interferometer is a compact, cost-effective, and easily fabricated sensor. The fiber's curvature causes interference between the core and cladding modes, which in turn results in the sensor operation. In the balloon-shaped curving section, light traversing the core partially escapes and interacts with the cladding. The preliminary results demonstrate an average displacement of 9.3 nm and the capability to evaluate breathing rate.

Th6.70 16:00–18:00 *Electromagnetic feedback fiber optic accelerometer with wide bandwidth and high sensitivity*

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A closed-loop fiber optic accelerometer with wide bandwidth and high sensitivity based on electromagnetic feedback is proposed. Compared with the open-loop system, the bandwidth of 3 dB can be extended to about 210 Hz, which is increased by about 3.5 times, and the sensitivity is maintained at 72.97 dB re rad/g. At the same time, the sensor can also realize free bandwidth regulation to a certain extent to meet different application requirements.

Th6.71 16:00–18:00 ***Exploring the application of Tamm plasmon resonance structures in fiber tips for remote hydrogen sensing***

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Hydrogen (H2) is a promising alternative to fossil fuels. However, safety concerns need constant monitoring, where fiber optical sensors can make a strong contribution. This work is based on Tamm Plasmon Resonance (TPR), which can be excited at normal incidence with depolarized light at the infrared range. Numerical and experimental results are presented that validate the possibility of using this approach for H2 detection, showing a wavelength shift of 8.5nm for 4 vol% H2 with the TPR band centered around 1565nm. The sensor presents a response time of 29s and a reset time of 27s. These findings open new avenues in the development of plasmonic optical fiber sensors for H2 sensing, as they enable the possibility of exciting plasmonic modes using single-mode optical fibers.

Th6.72 16:00–18:00 ***Optical fiber sensor for assessing asphaltene content in crude oil***

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An optical fiber sensor is described for monitoring asphaltene content in crude oil samples utilizing a no-core fiber segment spliced between two multimode fibers. The sensor assesses asphaltene precipitation in a crude oil/n-heptane solution correlating asphaltene concentration with the resulting optical fiber transmission loss. Tests on crude oil samples, from different extractions and oil deposits, revealed a distinct transmission loss per sample and an exponentially increasing loss trend with regard to asphaltene content.

Th6.73 16:00–18:00 ***Fluorescence-based optical fiber sensor for liquid sample analysis in silica glass well***

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Liquid samples are often of interest for various analytical purposes, requiring rapid, precise, portable, and easy-to-use equipment. Then, we proposed a portable system for fluorescence spectroscopy was developed, integrating an optical fiber sensor into a single-well plate. A proof-of-concept of the system was demonstrated using two different fluorescence samples: chlorophyll and cyanobacteria culture. The manufacturing method employed was ultrafast laser-assisted etching (ULAE), and the optical fiber was custom-mounted for tip-endcap integration. The fluorescence analysis demonstrated an enhancement in the signal of the liquid sample through the integration of the fiber capture system in the detector.

Th6.74 16:00–18:00 ***Calibrating ITER-fibre optic current sensor***

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A polarimetric-Fibre Optic Current Sensor (FOCS) is part of the plasma current diagnostic system at ITER. Its operating principle relies on the Faraday effect in optical fibres. When the fibre is looped around a section of the Vacuum Vessel (VV), the Faraday effect causes the polarization plane of the light to rotate proportionally to the current enclosed by the fibre. The rotation angle strength is defined by the Verdet constant V, a material-specific proportionality constant. However, the inevitable linear birefringence in the sensing fibres reduces the Faraday rotation angle, necessitating the calibration of the effective Verdet constant Veff of the sensing fibre before operation to accurately deduce the current from the measured Faraday rotation angle. This paper presents and experimentally demonstrates an approach for Veff calibrating with ITER-relevant calibration currents.

Th6.75 16:00–18:00 ***Extreme temperature fiber Bragg grating sensors for superconducting magnet and spacecraft applications***

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Fiber Bragg grating (FBG) sensors are increasingly applied to extreme environments from cryogenic temperatures for superconducting magnets including superconducting radiofrequency (SRF) cavities to the extreme cold and heat of space. Sensitivity and survivability can be enhanced with appropriate coatings. Results are provided for cyroprobes and high-temperature thermal probes with enhanced sensitivity and ruggedization.

Th6.76 16:00–18:00 ***Reaching mGy resolution in radiation sensing with a slow-light FBG***

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We report a gamma-radiation fiber sensor with record metrics, namely a dose resolution down to the milligray/√Hz level for a length of only 7 mm. The principle is based on the absorption of light due to the color centers induced in the fiber core by irradiation. Measurements are performed after irradiation, as color centers have a long lifetime. Absorption heats up the fiber, and the temperature rise is measured with a slow-light fiber Bragg grating in contact with the irradiated fiber. The temperature rise, measured in three fibers irradiated with different doses, is proportional to the irradiation dose and equal to 140 mK/Gy at an excitation power of 1 W at 1040 nm. The noise in the sensor output, measured using an Allan deviation technique, is as low as 1 mK/√Hz, leading to a dose resolution of 6 mGy/√Hz.

Th6.77 16:00–18:00 ***Optical fiber apta-biosensor for Alzheimer's disease via amyloid-β oligomers sensing based on polished microsphere-LSPR***

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Alzheimer's disease (AD) presents an increasing global health challenge, highlighting the need for early and accessible diagnostic methods. This study introduces a highly sensitive optical fiber apta-biosensor based on localized surface plasmon resonance (LSPR) for the early detection of Amyloid beta (1-42) (Aβ42), a crucial biomarker for AD. The RI sensitivity of the sensor was obtained at 716.53 nm/RIU which can be used as a good candidate for label-free biosensing. Upon Aβ42 binding, a distinct blue shift was observed, with a detection limit of 0.01 fM and a detection range from 50 fM to 5 μM. The sensor's high sensitivity, real-time monitoring, and label-free operation highlight its potential as a cost-effective alternative for early AD diagnosis, paving the way for widespread clinical applications.

Th6.78 16:00–18:00 ***Discrimination of strain and temperature using Bragg gratings in sidehole rectangular fiber and embedded reduced-cladding fibers***

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This work introduces a novel fiber Bragg grating (FBG) sensor design for discriminating strain and temperature effects using a side-hole rectangular fiber (SHRF) and embedded reduced-cladding fibers. An FBG in a single-mode fiber with a 75-μm cladding diameter, embedded within the SHRF air-hole, allows independent temperature measurements, while the SHRF FBG senses both strain and temperature. By embedding a polymer fiber with a 76-μm cladding diameter, the sensor achieved temperature sensitivity up to four times greater than that of the SHRF with SMF, enabling precise thermal discrimination. This compact, thermally-stable all-fiber sensor design effectively decouples strain and temperature without the need of complex packaging or a separate reference.

Th6.79 16:00–18:00 ***FBG-based temperature and fire sensors for use in industrial microwave ovens***

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Industrial microwave-heating systems play a crucial role in sectors such as food processing and materials manufacturing, where precise temperature control and safety are paramount. However, traditional systems often face challenges like uneven heat distribution and elevated fire risks due to the inherent characteristics of microwave heating. This study introduces a fiber-optic sensor-based monitoring system designed to address these critical issues. The system features an advanced fiber-optic sensor capable of 2D temperature distribution monitoring and a specialized fire detection mechanism, both aimed at significantly reducing risks and improving the heating process. Experimental results demonstrate the potential for transformative advancements in industrial heating technologies, paving the way for enhanced process efficiency and safety.

Th6.80 16:00–18:00 ***Artificial skin using photothermal optical fibers for material identification***

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This paper presents the development of an artificial skin that identifies materials through temperature changes upon contact. Utilizing a cobalt-doped photothermal optical fiber for heat generation and fiber Bragg gratings (FBGs) for temperature sensing, the system effectively monitors heat transfer, providing insights into material properties. Tested on metal, glass, and wood, an artificial neural network (ANN) achieves 100% recognition accuracy within five seconds of contact based on acquired material thermal evolution. This innovative approach enhances robotic tactile perception, paving the way for more reliable object recognition in robotic applications.

Th6.81 16:00–18:00 ***Hydrogen optical sensors based on magnesium thin films for leak detection in industrial settings***

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Hydrogen (H2) infrastructure is the focus of many initiatives for the planned energetic transition, but its volatility and flammability require extensive safety measures to prevent leakages and explosions. H2 optical fiber sensors based on magnesium(Mg) thin films have the potential to be both affordable and effective for scalable deployment in industrial settings. Multilayer thin-film structures with Mg and palladium were deposited on single-mode fiber tips, and H2 loading/unloading processes were tested in a controlled flow gas setup. An optical interrogation system prototype was developed, enabling fast data acquisition of fiber-tip reflectivity across multiple sensing probes at a wavelength of 1550 nm. Testing suggests fast response times of a few seconds for significant drops in reflectivity, facilitating straightforward detection of H2 leaks using thresholding methods.

Th6.82 16:00–18:00 ***Monitoring the manufacturing process and the operation of high voltage bushings with fiber optics***

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Fiber Bragg Gratings (FBGs) were used to monitor the manufacturing process and the operation of high voltage bushings. During operation, temperatures at several points inside the bushing were monitored. In another test, during bushing manufacturing, FBGs monitored the filling and curing process of the epoxy in Resin Impregnated Paper (RIP) bushings. Traditionally, temperature measurements inside the bushing core have been performed using thermocouple probes and only in bushings for research, not final products. The use of appropriate FBGs was successfully tested in the harsh environments of operation (under high voltage) as well as in manufacturing (high curing temperature and stress). The results demonstrate the potential of fiber optics to study and improve production methods. The study also shows that fiber optics are suitable for long-term monitoring during bushing operation.

Th6.83 16:00–18:00 ***Simultaneous measurement of position and vibration in correlation-domain LiDAR***

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In recent years, the growing adoption of autonomous vehicles has spurred significant interest in light detection and ranging (LiDAR), a technology that measures spatial object characteristics. Among various LiDAR techniques, we focus on correlation-domain LiDAR implemented using optical correlation-domain reflectometry (OCDR). OCDR enables simpler, lower-cost light sources, offers comparatively high spatial resolution, and provides random-access capability – allowing rapid measurements at any point along the fiber. Although correlation-domain LiDAR can, in principle, detect both the distance to a vibrating target and its vibration frequency, previously developed systems could not measure them simultaneously. Herein, we show that vibration-induced signals are already present in the distance measurement results, and by performing frequency analysis on these signals, we successfully measure position and vibration at the same time.

Th6.84 16:00–18:00 ***In situ monitoring and sensing of gas generation during internal short circuits in Li-ion batteries using Raman spectroscopy and fiber bundle signal collection***

Qilu Nie[a,b], Mengen Cheng[a,b], Dexun Yang[a,b], Shilong Pei[a,b], Yajie Li[a], Rong Ge[a,b], Donglai Guo[a,*], Minghong Yang[a,*]; [a]National Engineering Research Center of Fiber Optic Sensing Technology and Networks, Wuhan University of Technology, Wuhan, Hubei province 430070, China; [b]School of Materials Science and Engineering, Wuhan University of Technology, Wuhan, Hubei province 430070, China.*dlguo@whut.edu.cn; *minghong.yang@whut.edu.cn

This study investigates gas generation during internal short circuits in Lithium-ion batteries (LIBs) using a needle penetration test and Multi-Reflection Cavity-Enhanced Raman Spectroscopy. A fiber bundle with 48 fibers (105 μm diameter) enhances gas detection sensitivity. Infrared thermography and voltage measurements were conducted simultaneously to analyze temperature and voltage changes. Results showed a brief voltage drop and rapid temperature rise, indicating short circuit duration of a few seconds. Continuous generation of CH4, C2H4, and H2 was detected, highlighting the potential of Raman-based sensors for real-time safety monitoring in LIBs.

Th6.85 16:00–18:00 ***Study of a long-range perimeter intrusion detection system using deep learning based optical fiber distributed acoustic sensor***

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In this study, we propose a deep learning algorithm that analyzes signal data collected from DAS devices to prove the concept of PIDS capable of intrusion detection and event classification. The collected signals are processed in specific time units (timeframes), and an application is developed that provides the analyzed data in the form of a web interface using deep learning based on CNN (Convolutional Neural Network). The experiment collects data by attaching optical fibers to the fence and burying them in the ground simultaneously and then introducing various events, and then using them to perform learning and inference to verify the validity of the system.

Th6.86 16:00–18:00 ***Effect of gamma radiation on variously fabricated FBGs to verify the applicability of optical fiber sensors in radioactive environments***

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Fiber Bragg gratings (FBGs) are essential for sensing applications in extreme environments, such as those affected by gamma radiation. This paper compares the performance of FBGs fabricated using femtosecond (fs) and ultraviolet (UV) lasers under high-dose gamma irradiation. Three FBGs were subjected to controlled gamma radiation to assess their stability and potential for sensing under such conditions. The results reveal that fs-FBGs exhibit superior resistance to radiation-induced wavelength shifts, with only minor variations attributed to temperature fluctuations. In contrast, UV-laser-fabricated FBGs showed significant wavelength drift, rendering them less suitable for use in gamma-ray environments. These findings underscore the potential of fs-FBGs for precise sensing of temperature, pressure, and strain in high-radiation environments, such as nuclear reactors.

Th6.87 16:00–18:00 ***Lab-Around-Fiber for rapid biological agent detection***

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Conventional analytical instruments for biochemical detection are costly and complex, driving the need for compact, cost-effective biosensors. These devices integrate molecular recognition elements with detection transducers to link physical, chemical, and biological environments. LAF (Lab Around Fiber) aims to develop a device for the rapid and simultaneous detection of various biological threats (ricin, botulinum toxin, staphylococcal enterotoxin B, etc.) using optical fibers. This detection is made possible by two main tools: the inscription of fiber Bragg grating (FBG) within the fiber core and the biofunctionalization of the fiber outer silica surface with antibodies specific to the agents to be detected. This device is designed to combine low cost, high sensitivity, multiplexing, and compactness, enabling the biosensor to be used in the field. It is designed to identify the biological threat and quantify it using portable instrumentation.

Th6.88 16:00–18:00 ***High-performance fiber-optic hot-wire flowmeter based on surface plasmon resonance and PDMS***

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A novel and simple fiber-optic hot-wire flowmeter based on a polydimethylsiloxane-coated gold-plated multimode-no-core fiber tip is proposed and demonstrated. The gold coating not only excites the surface plasmon resonance effect but also absorbs the laser energy to generate heat. Additionally, the sensor probe is coated with a temperature-sensitive layer of PDMS. The flow of fluids dissipates heat, causing the PDMS to reach different thermal equilibrium temperatures corresponding to certain flow rates. The experimental results prove that the real-time response of PDMS to external microfluidics can be used to sense flow rate and temperature via monitoring the dip wavelength of SPR. The sensor achieves a maximum flow rate sensitivity of 7.27 nm/(μL/s), with a detection limit of 27.5 nL/s. The response time of the sensor to flow rate change is 1.31 s.The sensor offers high sensitivity, simple fabrication, low cost, and other advantages, thereby promoting the industrial application of all-fiber-optic flow rate sensing devices.

Th6.89 16:00–18:00 ***Single-mode helical sapphire fiber Bragg grating sensors fabricated by femtosecond laser direct writing technology***

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Sapphire fiber Bragg grating (SFBG) is a potential high-temperature sensor. In this paper, we have proposed the femtosecond laser direct writing technique (i.e., PbP, LbL and Pl-b-Pl) to fabricate Bragg gratings in sapphire fibers. The SFBGs with various Bragg wavelengths could be created flexibly by using these methods. Moreover, we have created a single-mode SFBG based on the helical structure, exhibiting a narrow bandwidth of 0.18 nm and a high reflectivity of 66.3%. Furthermore, the temperature sensing performance of SFBG was investigated. The results show that it could withstand the high temperature of 1900 °C and its temperature uncertainty was ±2.9 °C. Such an SFBG can be developed for temperature measurement in many fields, i.e., boilers, reactor cores, and aviation engines.

Th6.90 16:00–18:00 ***Optical fiber sensor for glyphosate detection combining the functionality of gold and plasmonic properties of silver thin films***

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This study explores the fabrication of plasmonic optical fiber sensors for detecting glyphosate using silver thin films deposited via the Tollens' reaction, enhanced with gold plating for protection. The silver films, created through electroless deposition, develop rough surfaces that form localized hotspots, amplifying the electromagnetic field. These effects were initially modeled with the finite element method (FEM) and subsequently confirmed by experimental assessments of the optical response. To combat silver's oxidation and corrosion, a layer of gold was added using the Kirkendall effect, which improved the sensors' chemical stability without compromising their plasmonic properties. The sensors, incorporating aptamers, detected glyphosate across a broad concentration range (10-1 to 104 µg/L), achieving a sensitivity of 25.08 ± 0.22 nm/(µg/L) and a detection limit of 0.04 µg/L – substantially below the EU's safety threshold. These results underscore the potential for using this method to produce sensitive, durable, and scalable environmental and agricultural monitoring sensors.

Th6.91 16:00–18:00 ***Etched single-crystal sapphire fiber Bragg gratings for simultaneous temperature and strain sensing at 1500 ºC***

Jun He[a,b,*], Zhuoda Li[a,b], Zhiwei Qin[a,b], Xizhen Xu[a,b], Zhiyong Bai[a,b], Yiping Wang[a,b]; [a]State Key Laboratory of Radio Frequency Heterogeneous Integration, Key Laboratory of Optoelectronic Devices and Systems of Ministry of Education/Guangdong Province, College of Physics and Optoelectronic Engineering, Shenzhen University, Shenzhen 518060, China; [b]Shenzhen Key Laboratory of Photonic Devices and Sensing Systems for Internet of Things, Guangdong and Hong Kong Joint Research Centre for Optical Fibre Sensors, Shenzhen University, Shenzhen 518060, China.*hejun07@szu.edu.cn

Sapphire fiber Bragg grating (SFBG) is promising for temperature and strain sensing in high temperature environments. An SFBG sensor has a cross-sensitivity of the strain and temperature, which significantly hampers its sensing performance. Here, we propose and demonstrate a compact sensing device for simultaneous temperature and strain measurements, which consists of two cascaded SFBGs with different fiber diameters. The SFBGs were inscribed with a femtosecond laser line-by-line scanning technique in a single sapphire fiber, in which a section was wet etched by using hot acid. The strain sensitivity of the etched SFBGs was measured. The strain sensitivity of the cascaded SFBGs is inversely proportional to its cross-sectional area of the fiber. Furthermore, a temperature and strain experiment of the etched SFBGs were performed and the strain sensitivities were 4.2 pm/µε and 0.9 pm/µε at 1500 °C.

Th6.92 16:00–18:00 ***Next-generation photonic crystal fiber based plasmonic sensor for heavy metal detection via spectroscopy and refractive index integration***

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Heavy metals (HM) contamination in water poses a serious threat to agricultural sustainability, environmental safety, human and animal health. HM contaminants like lead, cadmium, copper, and mercury can accumulate in crops, soil, and water systems, entering the food chain and impacting ecological balance. These HM containments are one of the main causes of life threating diseases. This research addresses the need for a high-precision, photonic crystal fiber (PCF) based surface plasmon resonance (SPR) sensor integrated with spectroscopy analysis, which is capable of detecting HM traces in water.

Th6.93 16:00–18:00 ***Development of a multi-core fiber Bragg grating-based axial tip force sensor for left-atrial appendage closure procedure***

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The left atrial appendage occlusion (LAAO) procedure is a minimally invasive method to reduce stroke risk in atrial fibrillation patients who cannot tolerate long-term anticoagulation therapy. Precise occluder deployment is crucial for proper sealing and avoiding complications. This study presents a compact axial tip force sensor based on multi-core Fiber Bragg Grating (FBG) technology, designed for the 1.25 mm delivery catheter of the Amplatzer Amulet LAA Occluder. The sensor uses a Nitinol flexure and multi-core FBG fiber to measure axial forces and supports 3D shape sensing. An off-center calibration method compensates for misalignments, decoupling axial and lateral forces. Experimental validation shows the sensor accurately measures forces up to 5 N with a mean absolute error of 0.16 N (1.50% of full range) and a resolution of 25 mN. This design improves occluder deployment precision, reduces reliance on tactile feedback, and enhances patient safety. While the study focuses on axial force sensing, the sensor also supports 3D shape sensing as well as triaxial tip force estimation.

Th6.94 16:00–18:00 ***Fiber laser LIBS as a sensing tool for chemical mapping of heritage tiles***

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Heritage preservation requires innovative sensing technologies to analyze their chemical composition while minimizing damage. This study introduces a Laser-induced Breakdown Spectroscopy (LIBS) system featuring a fiber laser source and optical fiber-based collection system for the analysis of heritage ceramics. Comparative experiments with a conventional Nd:YAG laser LIBS system highlight the advantages and trade-offs of the fiber laser system in terms of ablation capability, spectral mapping, and depth profiling. Results were validated against X-ray Fluorescence (XRF). Experiments demonstrate minimal surface alteration and high-quality spectral data for elements such as Pb, Fe, Zn, Sb, Mn, Ti Na, Ba and Ca. The compact design and good results position this system as a transformative tool for heritage conservation.

Th6.95 16:00–18:00 ***Graphene oxide for improved sensitivity and response time of fibre Bragg grating-based humidity sensors***

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We report on the characterisation of relative humidity sensors based on fibre Bragg gratings coated with two hygroscopic materials: polyimide (PI) and graphene oxide (GO). In both cases, sensitivity and response time could be tuned by varying the coating thickness, but graphene oxide provided significantly higher sensitivity and a faster response time than polyimide: for PI-coated sensors, a 1 pm/% increase in sensitivity resulted in a 94 s increase in response time, whereas for GO-coated sensors, the same increase in sensitivity only cost an additional 1 s increase in response time. These results show that graphene oxide is a promising material for faster-responding humidity sensors that can maintain high sensitivity.

Th6.96 16:00–18:00 ***Online monitoring of electric transmission lines using an optical ground wire with Distributed Acoustic Sensing***

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In this study, we demonstrate the measurement of electric power using an optical ground wire (OPGW). The tests were conducted on an OPGW cable from a high-voltage transmission line in Sines, Portugal, operating at 400 kV. A buried fiber position, free of 50 Hz and 100 Hz frequency interference, was selected to confirm that the 50 Hz frequency is not due to mechanical perturbation or electronic noise. Additionally, two suspended fiber positions (at 2500 m and 8500 m), where these frequencies were clearly observed, were analyzed. This study also examined the positioning of poles and splice detection between cables.

Th6.97 16:00–18:00 ***SPR-based tapered MCF sensor for monitoring of Poly (T) – Poly (A) binding***

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This work introduces a fiber-optic biosensor based on a surface plasmon resonance (SPR) based on tapered multicore fiber (MCF) for real-time DNA binding monitoring. The waist region is coated with a chromium and gold layer enabling high sensitivity to refractive index (RI) changes. The biosensor was functionalized using a dip-coating process, immobilizing Poly (T) aptamers on the SPR surface to bind Poly (A) nucleotides. The process involved applying a thiol-linked Poly (T) solution followed by an MCH blocking agent to improve coating uniformity and reduce nonspecific binding. The sensor demonstrated its capability to detect Poly (A) at varying concentrations (5 nM and 20 nM) through real-time monitoring of resonance wavelength shifts.

Th6.98 16:00–18:00 ***Staphylococcus aureus detection based on tapered MCF***

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This work introduces a tapered multicore fiber (MCF) biosensor designed for the detection of Staphylococcus aureus using a specific aptamer-binding assay. The biosensor employs a 7-core MCF, with the tapered structure featuring a waist diameter of 20 µm and a waist length of 40 mm. The functionalization process involves the immobilization of aptamers on the fiber surface, enabling the sensor to specifically bind to S. aureus. Detection involves immersing the sensor in phosphate-buffered saline (PBS) for reference measurements, followed by the addition of S. aureus samples at concentrations of 10^5, 10^6, and 10^7 CFU/mL. The results demonstrate that the sensor successfully differentiates between varying concentrations. Additionally, the biosensor's selectivity was verified by comparing S. aureus detection to S. epidermidis.

Th6.99 16:00–18:00 ***Effect of adhesives on the spectral response of Bragg gratings embedded on Sapphire wafer in extreme cryogenic temperatures***

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Emerging fusion energy and electric aviation technologies rely on superconductors that work in extreme cryogenic environments. Fiber Bragg gratings (FBGs) have emerged as critical components in temperature profiling under such extreme environments. In this study, we characterize a temperature sensor for the superconducting dynamo-based power supply using FBGs. We studied the spectral response of FBGs at cryogenic temperatures using different bonding adhesives. Among the different cryogenic adhesives used, the FBGs bonded with Apiezon N were found to be more reliable.

Th-100 16:00–18:00 ***Simultaneous measurement of temperature and ionizing radiation dose based on type-II FBGs inscribed in P-doped optical fibers***

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A novel approach for the simultaneous measurement of radiation dose and temperature using fiber Bragg gratings (FBGs) inscribed on phosphorus (P)-doped optical fibers is proposed. For the first time, a Type-II FBG inscribed on a P-doped optical fiber was irradiated within the core of a nuclear reactor, exposing the sensor to both neutron and gamma radiation. This work provides new insights into the effects of reactor irradiation on Type-II FBGs in P-doped fibers, demonstrating that the radiation-induced Bragg wavelength shift is comparable to FBGs inscribed in pure silica core. Furthermore, the reactor irradiation serves to illustrate the proposed method for simultaneous temperature and radiation dose sensing using a single FBG. The proposed technique can be easily multiplexed along a single optical fiber to provide multiple sensing points, each capable of discriminating temperature and radiation dose. While the method is constrained by the maximum radiation dose at which the P-doped fiber experiences total darkening, it remains applicable for a wide range of environments, including ex-core measurements in nuclear reactors and various locations within particle accelerators.

Th6.101 16:00–18:00 ***Fiber optical current sensor for quasi-DC currents during high voltage short-circuit tests***

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The transition towards sustainable energy systems presents significant challenges for existing power grid infrastructures, especially with the increasing occurrence of quasi-DC currents caused by renewable energy integration, electromobility, and electrified transportation. These quasi-DC currents impose thermal stress on transformers and reduce their service life, necessitating advanced measurement technologies. This study introduces a fiber-optical current sensor (FOCS) based on a modulated Sagnac interferometer, designed to detect and analyze fault currents during short-circuit events in high-voltage substations. The sensor exploits the Faraday effect for highly sensitive and accurate current measurement, overcoming limitations of conventional inductive transducers, such as core saturation and limited bandwidth. Field tests in a 110}kV substation demonstrate the FOCS's superior performance, including enhanced sensitivity, a stable zero point, and the ability to quantify quasi-DC components. These results highlight the FOCS's potential for reliable fault current monitoring in modern power grids, addressing critical challenges posed by sustainable energy transitions.

Th6.102 16:00–18:00 ***Decoupling temperature and humidity with chitosan-coated tilted FBG sensor***

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This work proposes a chitosan-coated tilted fiber Bragg grating sensor for the first time to simultaneously monitor temperature and relative humidity (RH). The sensing principle used allows for the discrimination between temperature and RH as the Bragg peak was verified to be insensitive to RH while exhibiting a measured sensitivity to temperature of (8.7 ± 0.1) pm/°C. On the other hand, the sensitivities of the spectral minimum peak, corresponding to a cladding mode, were measured as (8.0 ± 0.1) pm/°C and (0.88 ± 0.06) pm/%RH for temperature and RH, respectively.

Th6.103 16:00–18:00 ***High-sensitivity dual-disk fiber-optic vibration sensing with wideband flattened response***

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The sensitivity and resonant frequency of the fiber-optic accelerometer are contradictory, both being limited by the sensor's size and mechanical parameters. This paper presents a dual-disk structure that incorporates liquid damping, enabling the adjustment of the system's damping ratio. This approach effectively suppresses the resonance peak and flattens the amplitude-frequency response. Experimental results show that the sensor's resonance peak is effectively suppressed, with a working bandwidth of up to 329 Hz, a sensitivity of 17,722 rad/g, and a theoretical resolution of 0.38 ng/√Hz@10 Hz.

Th6.104 16:00–18:00 ***Highly strain sensitivity sensor by long period fiber grating inscribed in multi-mode fiber using CO2 laser***

Hang Su, Yunqi Liu*, Yuehui Ma, Siyu Chen, Chengbo Mou; Key Laboratory of Specialty Fiber Optics and Optical Access Networks, Shanghai Institute for Advanced Communication and Data Science, Joint International Research Laboratory of Specialty Fiber Optics and Advanced Communication, Shanghai University, Shanghai, China. *yqliu@shu.edu.cn

We propose a novel long period fiber grating (LPFG) with enhanced strain sensitivity, which is inscribed in hydrofluoric acid-etched multi-mode fiber (MMF) by a CO2 laser. Experimental results indicate that the strain sensitivity of the LPFG progressively increases as the MMF diameter decreases, while the temperature sensitivity remains consistently stable at -575.58 pm/°C. Notably, when the fiber diameter is reduced to 61 μm, the strain sensitivity achieves a remarkable value of -177.93 pm/με. The proposed LPFG offers several advantages, including compact design, ease of fabrication, linear response characteristics, high sensitivity, and low cost. Thus, it holds significant promise for widespread application in industrial fields such as health monitoring of bridge structures, seismic physical detection, and fire alarm system.

Th6.105 16:00–18:00 ***Hydrogel-integrated FBG sensors for real-time pH monitoring***

Doua Kosaji[a,b], Nazmi B. Alsaafeen[a,b], Mohammad I. Awad[a,b], Kinda Khalaf[a,b], Anna-Maria Pappa[a,b], M. Fatima Domingues[a,b,c,*]; [a]Department of Biomedical Engineering and Biotechnology, Khalifa University, Abu Dhabi, UAE; [b]Healthcare Engineering Innovaation Center, Khalifa University, Abu Dhabi, UAE c Instituto de Telecomunicações-University of Aveiro, Portugal.*fatima.domingues@ua.pt

The growing need for precise monitoring of critical parameters like pH has driven significant advancements in sensing technologies. FBG sensors, known for their high precision and adaptability, have emerged as a transformative tool for real-time measurements. This study explores the integration of an FBG sensor with a pH-responsive hydrogel to develop a system capable of accurate, real-time pH monitoring. The hydrogel exhibited measurable responses to pH variations, effectively translating these changes into wavelength shifts detected by the FBG sensor. Testing was conducted across a pH range of 3 to 7, with notable sensitivity in acidic conditions. This innovative system demonstrated high sensitivity of 4.1±0.7pm/unit pH, emphasizing its potential for diverse applications such as healthcare, environmental monitoring, and industrial processes

Th6.106 16:00–18:00 ***Torque and rotational speed FBG-based measurements by sensorized FDM support structure for aerospace applications***

Gustavo Saturno[1,*], João Cunha[2], Vitorino Biazi-Neto[1], Rui Moreira[2,3,4], Jan Nedoma[5], Andreas Ioannou[6], Kyriacos Kalli[6], Radek Martinek[7], Carlos Marques[1,8]; [1]CICECO – Aveiro Institute of Materials & Physics Department, University of Aveiro, Aveiro, Portugal; [2]Department of Mechanical Engineering, University of Aveiro, Aveiro, Portugal; [3]TEMA – Centre for Mechanical Technology and Automation, University of Aveiro, Aveiro, Portugal; [4]LASI - Intelligent Systems Associate Laboratory, Aveiro-Portugal;[5]Department of Telecommunications, VSB – Technical University of Ostrava, Ostrava, 70800, Czech Republic; [6]Photonics & Optical Sensors Research Laboratory (PhOSLab), Cyprus University of Technology, Limassol 3036, Cyprus; [7]Department of Cybernetics and Biomedical Engineering, VSB – Technical University of Ostrava, Ostrava, 70800, Czech Republic; [8]Department of Physics, VSB – Technical University of Ostrava, Ostrava, 70800, Czech Republic.*Gustavo.saturno@ua.pt

This paper presents a fiber Bragg grating (FBG) based sensor integrated into an additively manufactured structural support component for a motor. The sensor embeds two optical fibers each with three FBGS and leverages the linear relationship between strain and torque to estimate the applied torque by monitoring the Bragg wavelength shift of each FBG. While the use of polymers, enabled by fused deposition modeling (FDM), simplifies manufacturing, it introduces short-term creep due to the viscoelastic nature of the material. To mitigate this, polyethylene terephthalate glycol (PETG) was chosen for its superior short-term creep resistance. Additionally, a one-dimensional Kalman filter was implemented during signal processing to minimize creep-related noise. The sensor's design also accounts for torque ripple, a cyclic torque variation related to motor rotation, which allowed the

measurement of rotational speed by applying a fast Fourier transform (FFT) to the sensor output and analyzing the dominant frequency. This dual-functionality sensor is tailored for characterizing state-of-the-art toroidal and conventional propellers, offering simultaneous torque and RPM measurements.

Th6.107 16:00–18:00 ***Effect of core breakage on measurement symmetry in shape sensing based on optical fiber sensors***

Leonardo Rossi[a,*], Francesco Falcetelli[b], Raffaella Di Sante[b], Gabriele Bolognini[a]; [a]Consiglio Nazionale delle Ricerche, ISMN Institute, Via Gobetti 101, 40129 Bologna, Italy; [b]Department of Industrial Engineering, University of Bologna, Via Fontanelle 40, 47121 Forlì, Italy

We present a study of the behavior of shape sensing applications based on strain sensors and sensing cables based on fiber bundles in the case when one of the sensing core breaks. In particular, we perform Monte Carlo simulations for the estimation of the parameters of a curvature vector (magnitude and bending direction) at different bending angles, showing how, when the core breaks, the accuracy of the measurement is no longer symmetrical, and characterize the accuracy of magnitude and direction of the vector as a function of the bending angle.

Th6.108 16:00–18:00 ***Gas sensing inside hollow-core fibers***

Michał Nikodem[a,*], Patrycja Gronowicz[a], Piotr Perehiniec[a], Ryszard Buczynski[b,c]; [a]Department of Optics and Photonics, Wroclaw University of Science and Technology, Poland; [b]Łukasiewicz Research Network – Institute of Microelectronics and Photonics, Poland; [c]Faculty of Physics, University of Warsaw, Poland.*michal.nikodem@pwr.edu.pl

Laser-based spectroscopy in the infrared region is critical for applications requiring trace-level gas detection with high selectivity. While multi-pass cells are traditionally employed to enhance sensitivity by extending the optical path length, their bulkiness, mechanical sensitivity, and alignment challenges limit their practicality. Hollow-core fibers (HCFs) provide a compact alternative to multi-pass cells.

In this work we will presents a novel reflective, dual-pass sensing configuration utilizing antiresonant HCFs for gas detection. In this setup, a 60-cm-long HCF serves as both a gas cell and a sampling probe, with laser light entering and exiting from the same side. The reflective configuration eliminates the need for additional tubing, minimizing dead volume and reducing the sample volume required. Additionally, the effective path length is doubled, enhancing detection sensitivity while maintaining a rapid sensor response time of ~2.5 seconds. To demonstrate probe performance, methane detection near 3270 nm will be presented.

Th6.109 16:00–18:00 ***Plasmonic immunosensors based on POF D-shaped for detection of ochratoxin A***

Thais de Andrade Silva[1,*], Francesco Arcadio[2], Nunzio Cennamo[2], Luigi Zeni[2], Servio Tulio Cassini[1], Jairo Pinto de Oliveira[1], Carlos Marques[3,4]; [1]Federal University of Espírito Santo, Av Marechal Campos 1468, Vitória, ES 29.040-090, Brazil; [2]University of Campania Luigi Vanvitelli, Department of Engineering, Via Roma 29, 81031, Aversa, Italy; [3]CICECO – Aveiro Institute of Materials & Physics Department, University of Aveiro, Campus Universitário de Santiago, 3810–193, Aveiro, Portugal; [4]Department of Physics, Faculty of Electrical Engineering and Computer Science, VSB—Technical University of Ostrava, Ostrava, Czech Republic. *thaisandrade1213@hotmail.com

The high toxicity and occurrence of ochratoxin A (OTA) in grains and foods has been a growing concern due to the impacts on health and the economy in many countries. In this sense, simplified devices with high sensitivity and specificity for local monitoring are enthusiastically pursued. In this work, we report for the first time the detection of ochratoxin As using a POF D-Shaped immunosensor. The biosensor was built with the surface of the POF D-Shaped covered by a 60 nm layer of gold to enable the SPR phenomenon. An optical immunosensor based on SPR phenomena, was successfully developed for the ultra-low detection of OTA, with limit of detection was 0.5 ppt. Furthermore, the developed biosensor represents a promising analytical device for coffee quality analyses, as it is portable, simple, and suitable for onsite detection of target analytes without microfluidic systems.

Th6.110 16:00–18:00 ***FBG-based optical extensometer for high-precision mechanical tests***

Tulio Gonçalves[1,*], Gustavo Saturno[1], Carlos Marques[1,2]; [1]CICECO – Aveiro Institute of Materials & Physics Department, University of Aveiro, Aveiro, Portugal; [2]Department of Physics, VSB – Technical University of Ostrava, Ostrava, 70800, Czech Republic.*Tuliomanuel.pg@ua.pt

This paper presents the theoretical basis for a fiber Bragg grating (FBG) based extensometer for high-precision mechanical tests. This is achieved by employing a compression mechanism with a highly stiff spring, that upon being extended transfers strain to the axis of a metal cylinder that has a bare SMF optical fiber inscribed with FBGs. The use of an etched fiber should improve sensitivity while neglecting the disadvantage of the brittleness that comes with it when embedding it into a housing metal cylinder. Upon this basis a theoretical model for strain transfer for the extensometer was developed and validated through a finite element method (FEM) analysis. This approach demonstrated the potential for achieving a sensitivity of up to 6.80 µm on the extensometer, offering a new and potentially more cost-effective solution compared to existing commercially available options.

Th6.111 16:00–18:00 ***Estimating fiber borehole seismometer orientation using active-source P-wave particle motion analysis***

Guoheng Qi[a,b], Kunbi Zhu[a,b], Wenzhu Huang[a,b], Wentao Zhang[a,b,*], Fang Li[a], Liwei Wang[c], Li Li[d]; [a]Institute of Semiconductors, Chinese Academy of Sciences, Beijing 100083, China; [b]Center of Materials Science and Optoelectronic Engineering, University of Chinese Academy of Sciences, Beijing, 100049, China; [c]China Earthquake Administration Key Laboratory of Earthquake Monitoring and Disaster Mitigation Technology, Guangdong Earthquake Agency, Guangzhou 510070, China; [d]Institute of Geophysics, China Earthquake Administration, Beijing 100017, China. *zhangwt@semi.ac.cn

The accurate orientation of the seismometers is crucial for seismic observation and data processing. However, determining the orientation of an all-fiber instrument, such as a fiber optic borehole seismometer, remains a challenge in special environments such as downhole or water. We propose a fiber optic borehole seismometer orientation estimation method to address these challenges using active-source seismic data. We rotate the horizontal component of the seismometer until we find an angle that satisfies the maximum value of the P-wave energy in the radial direction and finally calculate the orientation of the horizontal component from this angle. We applied this method to estimate the orientation of the fiber optic borehole seismometer in Leizhou. The potential applicability of this method may extend beyond fiber borehole seismometers to other borehole instruments, such as traditional borehole broadband seismometers.

Th6.112 16:00–18:00 ***Cell movement monitoring using microcavity Mach-Zehnder interferometer***

Tomasz Gabler[a,*], Joanna Witkowska[b], Monika Janik[a], Mariusz Zdanowicz[c], Marcin Koba[a,c], Anna Grabowska[b], Dariusz Szukiewicz[b], Mateusz Śmietana[a,d], [a]Warsaw University of Technology, Institute of Microelectronics and Optoelectronics, Koszykowa 75, 00-662 Warsaw, Poland; [b]Medical University of Warsaw, Department of Biophysics, Physiology and Pathophysiology, Chałubinskiego 5, 02-004 Warsaw, Poland; [c]National Institute of Telecommunications, Szachowa 1, 04-894 Warsaw, Poland; [d]Łukasiewicz Research Network – Institute of Microelectronics and Photonics, Department of Glass, al. Lotników 32/46, 02-668 Warsaw, Poland.*tomasz.gabler.dokt@pw.edu.pl

In this work, we report the application of a microcavity in-line Mach-Zehnder interferometer (µIMZI) fabricated in a single-mode optical fiber as a novel tool for high-sensitivity, non-invasive, real-time cell movement monitoring. The finite-difference time-domain method has been used to identify interactions between the electromagnetic field and cellular structures within the µIMZI. Next, the simulations considering local refractive index variations within the cavity provided a predictive framework for interpreting experimentally achieved µIMZI optical responses to cellular movements. By correlating simulated field distributions with experimental spectral features, this study demonstrates how numerical modeling enhances the understanding of dynamic processes such as cell adhesion, morphology changes, proliferation, and cell layer integrity. This method allows for efficient monitoring of changes in the several micrometers thick cell layer, which is typical for endothelial cells. Following endothelial cell behavior in real-time using µIMZI opens the possibility of in vitro modeling of more complex processes, such as the formation and functioning of the blood-brain barrier.

W7 *Conference Banquet*

20:00–24:00

Friday May 30th 2025

F1 Session
9:30–11:00

Physical, Mechanical and Eletromagnetic Sensors

CHAIRS

Dr. Gabriele Bolognini
Istituto per la Microelecttronic e Microsistemi (Italy)

Prof. Luc Thévenaz
EPFL (Switzerland)

F1.1 9:30–10:00
INVITED

Dr. Austin Taranta
University of Southampton (United Kingdom)

Recent Advances in Antiresonant Hollow Core Fibers for the Next Generation of Gyroscopes and Precision Fiber Sensors

Antiresonant hollow core fiber (HCF) is reaching large-scale commercial deployment for data transmission, where low latency and ultra-low loss form key advantages over conventional solid core fibre. But the greatest benefits of this rapidly maturing technology will perhaps be realized by optical fiber sensors, such as fibre-optic gyroscopes. Here the tailorable operating window, customizable light-gas interaction, and orders-of-magnitude improvements to backscatter, nonlinearity, and environmental impairments afforded by HCF can be transformative. This review examines the state-of-the-art in HCFs, highlighting recent breakthroughs that make them a compelling platform for advanced fiber-optic gyroscopes and optical systems across a variety of applications.

F1.2 10:00–10:15

Resolving twist-induced errors in fiber optic shape sensing via polarization-sensitive reflectometry

Arman Aitkulov[a]*, Martina Cappelletti[a], Daniele Orsuti[a]†, Luca Schenato[a], Marco Santagiustina[a], Andrea Galtarossa[a], and Luca Palmieri[a]; [a]Department of Information Engineering, Via Gradenigo 6/B, Padova, Italy.*arman.aitkulov@phd.unipd.it

We present a new technique for removing twist-induced distortions in fiber optic shape sensing. In the method, a standard swept-wavelength reflectometry is used to perform polarimetric measurements, which allows to extract the strain necessary for shape reconstruction as well as the twist evolution along the fiber. By applying a model that synthesizes these two parameters, we demonstrate a significant improvement in 3D-shape reconstruction, achieving an accuracy of 3.6-mm/m in reconstructing an helical shape, even in the presence of uncontrolled twist.

F1.3 10:15–10:30 ***Femtosecond laser-inscribed large-scale fiber Bragg grating arrays for distributed sensing in harsh environments***

Jun He*[a,b], Baijie Xu[a,b], Yanjie Meng[a,b], Cailing Fu[a,b], Xizhen Xu[a,b], and Yiping Wang[a,b]; [a]State Key Laboratory of Radio Frequency Heterogeneous Integration, Key Laboratory of Optoelectronic Devices and Systems of Ministry of Education/Guangdong Province, College of Physics and Optoelectronic Engineering, Shenzhen University, Shenzhen 518060, China; [b]Shenzhen Key Laboratory of Ultrafast Laser Micro/Nano Manufacturing, Guangdong and Hong Kong Joint Research Centre for Optical Fibre Sensors, Shenzhen University, Shenzhen 518060, China.*hejun07@szu.edu.cn

Ultra-weak fiber Bragg grating (UWFBG) arrays are key elements for constructing large-scale sensing networks for structural health monitoring. Conventional methods for creating UWFBG arrays rely on in-line UV exposure during fiber drawing. However, these UV-induced UWFBG arrays cannot withstand a high temperature above 450 °C. Here, we report a method for fabricating high-temperature-resistant UWFBG arrays using femtosecond laser direct writing technology. Three types of UWFBG arrays, i.e., identical UWFBG array, sapphire fiber FBG(SFBG) array and seven-core fiber (SCF) FBG array, were successfully fabricated. Moreover, these fabricated UWFBG arrays were used for distributed high-temperature sensing (DTS), distributed acoustic sensing (DAS) and 2D and 3D shape sensing. The proposed UWFBG array play an important role in promoting distributed sensing, especially in extreme environments.

F1.4 10:30–10:45 ***Application of PM-EDF ring laser with cascaded-chirped LPG to intensity-modulation based acoustic sensing***

Satoshi Tanaka, Makoto Okano, Atsushi Wada; Department of Communications Engineering, National Defense Academy Hashirimizu 1-10-20, Yokosuka, Kanagawa 239-8686, Japan

We have proposed EDF laser sensors using cascaded chirped long-period optical fiber gratings (C-CLPGs) as wavelength selection elements and sensing devices, and have been investigating their high performance. In particular, we demonstrated that a σ-cavity EDF laser with a double-pass C-CLPG configuration assisted by a Faraday-rotation-mirror (FRM), enabling round-trip transmission through the C-CLPG within the cavity (EDFσL) achieves a birefringence compensation effect in the C-CLPGs, which enables stable oscillation even during sensing operations. Furthermore, we previously proposed a novel polarization-maintaining EDFσ laser (PM-EDFσL) using a polarization-maintaining EDFA (PM-EDFA) to realize a high-precision laser-type sensor with enhanced oscillation stability. In this study, we achieved highly stable oscillation output in the PM-EDFσL and explored its application to acoustic sensing based on intensity-modulation scheme. Experimental results successfully demonstrate the detection of mechanical vibrations.

F1.5 10:45–11:00 ***Transient fiber optical current sensing during high-voltage short-circuit events***

Philipp Peter Trampitsch[a], Reinhard Klambauer[a], Johannes Michael Mandl[a], Jurgen Plesch[b], Werner Schoffer[b], and Alexander Bergmann*[a]; [a]Institute of Electrical Measurement and Sensor Systems, Inffeldgasse 33/1, Graz, Austria bArtemes GmbH, Eibiswald 105, Eibiswald 8552, Austria.*alexander.bergmann@tugraz.at

This work aims to demonstrate fiber optical current sensors for high frequency measurement of electrical currents at high voltage level in the field. A non modulated Sagnac interferometer utilizing the Faraday effect is built and used. Current events with a bandwidth of approximately 100 kHz were recorded in the field. Although there were problems with the stability of the operating point it was determined that an optical system is suitable for the high-frequency recording of electrical currents. A reference measurement with a conventional induction current probe was not able to record these high frequent events.

F2 Post Deadline Session

11:30–12:45

CHAIRS

Prof. Jose Miguel Lopez Higuera
Universidad de Cantabria (Spain)

Prof. Zuyuan He
Shanghai Jiao Tong University (China)

F3 Closing Cerimony

12:45–13:15

16:00–17:00 **Douro River Trip**

For more information visit
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Following the light