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Elfed Lewis
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Introduction

Welcome to the University of Limerick, Ireland and to the sixth edition of the European Workshop on Optical Fibre Sensors, 6th EWOFS'2016. Following the successful events in Peebles (1998), Santander (2004), Napoli (2007), Porto (2010) and Krakow (2013), the University of Limerick has the privilege to host and organize the 2016 meeting, EWOFS'2016.

This unique meeting aims at promoting a scientific agenda with a high level of interaction between participants, enabling an open debate and the assessment of new concepts, technologies and applications in the domain of optical fibre sensors, as well as establishment of new collaborations and networks. EWOFS'2016 also intends to complement in time and geographical location the international conferences in this area, and in particular the International Conference on Optical Fibre Sensors (OFS).

Addressing scientific achievements, technological applications and commercial exploitation, our goal is to create a programme that will be attractive for academics and professionals working in this area. The meeting will include a set of high-level invited speakers that will consider topics related to optical fibre sensors as well as other scientific domains that may cause an impact on their future development. Also, we will seek to strengthen the Workshops' unique features, including the discussion of technical contributions between early stage researchers and experienced practitioners, identifying and highlighting the most significant contributions. Many contributors will also be from an industrial background which is indicative of the growth of Optical Fibre Sensors in the commercial arena. The Workshop will include an invigorating and appealing Social Programme that will complement the scientific focus of the event and encourage real socialisation amongst all attendees.

Since past and future meet in the present, we intend to make EWOFS'2016 an opportunity to promote the productive interaction between early stage scientists, engineers and mature practitioners in this scientific and technological adventure around the subject of optical fibre sensors. At the same time, we want to honour the pioneers who have significantly contributed to its development, and encourage young researchers who have chosen to work in this field.

As we progress through the early part of this new century and millennium, humankind continues to face great challenges in the search for a future characterized by global justice, fair and sustainable progress, as well as economic and social wealth. This is a demanding goal, and it is essential that Science and Technology create opportunities so that society may evolve with that purpose. In its specific domain of Optical Fibre Sensors, EWOFS'2016 continues to encourage scientific and technological advances, and provide a forum where early stage

and experienced researchers and entrepreneurs may interact in a mutually profitable relationship that is oriented to the development of optical fibre sensors and their impact on society. Pursuing this central objective, we are committed to giving our utmost for the delivery of the best possible technical and social atmosphere at EWOFS'2016. Our ultimate wish is that you will enjoy your visit to the University of Limerick and the surrounding regions of Mid-West Ireland in May/June 2016.

Elfed Lewis
Brian Culshaw
José Miguel López-Higuera
Andrea Cusano
José Luís Santos
Leszek R. Jaroszewicz

Invited Lectures

Sensing rotation with light: from the fiber optic gyroscope to slow-light structures
Michel Digonnet, Stanford Univ. (United States)

First proposed 40 years ago, the fiber optic gyroscope (FOG) is one of the most complex and interesting fiber sensors, and it was also paradoxically one of the first to be fully developed and commercialized. This keynote will describe the physical principles of the FOG, and the clever optical engineering solutions that have led to its extraordinary precision. Recent research efforts to implement broadened lasers and photonic-bandgap fibers to improve its performance and achieve inertial navigation of aircraft will also be presented. The talk will end with a discussion of the resonant fiber optic gyroscope and other slow-light rotation sensors.

Hybrid multi-material optoelectronic fibers
Fabien Sorin, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

The development of multi-material fibers that combine materials with different optical, electrical and optoelectronic properties has heralded a novel path towards optical fiber-based sensing. Complex optoelectronic functionalities can be achieved by combining all of the required materials into a macroscopic preform and using the thermal drawing process to stretch these structures into very long, thin, and flexible functional devices. In this talk, I will present the development of multi-material optoelectonic fibres amenable to the distributed detection of optical radiation. After describing the fabrication approach and materials requirements, I will show how successive milestones have enabled improved performance and functionality by engineering new materials and increasingly complex cross-sectional structures. I will conclude by highlighting some directions that the field may take in terms of new materials, structures and functionalities.

Is LMR the new SPR?
Francisco J. Arregui, Public University of Navarra (Spain)

Recently, the potential use of optical sensors based on Lossy Mode Resonances (LMR) has been proposed, simulated and experimentally demonstrated in the literature. LMR sensors have some similarities with Surface Plasmon Resonance (SPR) sensors, the gold standard in label-free, real-time biomolecular interaction analysis. These hardly explored and studied LMR sensors are based on a non-metallic nano-cladding deposited on the core of an optical fiber. If this nanocoating fulfils the conditions explained in this work, coupling of light to the cladding modes happens at certain resonance wavelengths. The refractometric response of the LMR sensors,

in the same way that SPR sensors, opens the door to numerous applications. In this early stage of research, a giant sensitivity of 304,360 nm per refractive index unit (nm/RIU) has been already observed.

Bio/medical detection using optical fibers

Robert Lieberman, Lumoptix LLC (United States)

A variety of fiber optic sensors have been developed to address specific problems in biochemical detection, biomedical diagnosis, and medical treatment. Point-of-care testing, real-time health monitoring, environmental quality determination, surgical procedures, and fundamental cellular physiology studies all benefit from the unique advantages offered by light-based approaches to quantitative measurement. This presentation summarizes the principles of several different physical and chemical biosensors, both "active" and "passive," and gives examples of practical applications and future prospects for devices and systems based on these principles.

Biochemical sensing using advanced metrology methods on an optical fiber surface

Jacques Albert, Carleton Univ. (Canada)

New understanding on how very specific vector cladding modes can be excited in optical fibers by weakly tilted FBGs provides new tools for measuring optical properties and probing biomolecular reactions at the fiber surface. The presentation will discuss these advances and highlight recent results that are pushing detection limits close to those obtained by conventional laboratory instrumentation.

Hybrid optoplasmonic platforms for sensing and spectroscopy: from new physics to new functionalities

Svetlana V. Boriskina, Massachusetts Institute of Technology (United States)

I will discuss our efforts in developing hybrid optoplasmonic architectures to tailor resonant energy transfer between photons, plasmons, quantum emitters and elementary heat carriers. Near- and far-field electromagnetic coupling between plasmonic and photonics elements can be tailored to trigger new physical effects, which add new functionalities to optoplasmonic platforms. Among the emergent properties of optoplasmonic structures is their ability to simultaneously achieve extreme spectral and spatial localization of light, making possible ultrasensitive schemes for optical detection, spectroscopy, and imaging. Counter-intuitively, the enhanced light focusing in optoplasmonic structures may be accompanied by reduced absorption in their metal constituents. Furthermore, hybrid systems can de designed to provide passive cooling via radiative heat extraction. A combination

of the strong light localization and spectral selectivity achievable under lower operating temperatures in optoplasmonic devices yields many applications in ultrasensitive detection, spectroscopy, imaging, thermal emission manipulation and radiative cooling.

Liquid and solid nanowires in fibers: a new base for plasmonic nanoprobes and single virus sensing

Markus A. Schmidt, Leibniz Institute of Photonic Technology e. V. (Germany)

Hybrid optical fibers are fibers which include sophisticated materials which are traditionally not used within fiber optics. As a result, fiber-based devices with unprecedented properties can be envisioned, ultimately opening up new fields for fiber optics such as plasmonics or optofluidics. I will discuss that the plasmons on metallic nanowires can be described as spiraling planar plasmons which are strongly influenced by curvature-induced geometric momenta, and presents our first results on fiber-integrated nearfield nanoprobes. During the second part I will report on tracking the Brownian motion of nanoparticles inside optofluidic nanobore fibers, allowing the detection of single viruses with diameters below 20 nm via elastic light scattering.

Distributed acoustic sensing: technology and applications

Arthur Hartog, Schlumberger Fiber-Optic Technology Ctr. (United Kingdom)

The paper discusses the different approaches to providing a measure of the distribution of vibration along an optical fibre, both as a measure of the acoustic energy and as a transducer of the local vibration signal. We discuss the optics of the interrogation and nature of the measurement particularly as it applies to borehole geophysical surveying. Some examples of results obtained in recent downhole seismic acquisitions will be shown. Limitations, challenges and opportunities will be addressed.

Opto-mechanical analysis of liquids outside the cladding of standard fibre

Avi Zadok, Bar-Ilan Univ. (Israel)

Current fiber sensors of surrounding media rely on spatial overlap between the optical mode and the substance under test, which mandates structural modifications. This work reports the analysis of liquids outside the cladding of standard, unmodified fiber, using optical waveforms that are confined to the core. Measurements are based on the stimulation and probing of acoustic modes of the fiber structure, and recover the acoustic cavity lifetime and the acoustic reflectivity at the outer boundary of the cladding. The acoustic impedance of water and ethanol is measured with 1% accuracy. Measurements distinguish between aqueous solutions with different levels of salinity.