

Clinical and Biomedical Spectroscopy

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Introduction

In recent years spectroscopy has gained further importance in the field of biophotonics and has become a very helpful tool for biomedical research. The advancement of the techniques have opened the door for a variety of most valuable clinical applications, e.g. for ophthalmology, skin, point of care and minimally invasive diagnostics as well as for the characterization of tissue. Spectroscopic methods provide detailed structural and functional information on organs, tissues, and body liquids. Starting from basic biomedical applications to achieve a full understanding of the principles of cellular and even sub-cellular processes, a full picture on the molecular level can be gained to comprehend the interplay which leads to the transformation of normal to diseased tissue, e.g. the development of malignant tumors. Such an understanding of the genesis of diseases will eventually lead to the development of new and more effective treatment modalities. This will require an interdisciplinary platform for physicians, physicists, biologists, chemists, and related researchers. Such a platform is provided by the conference on Clinical and Biomedical Spectroscopy.

The conference in the framework of the European Conferences on Biomedical Optics (ECBO) consisted this year of 80 presentations, 5 of which were invited talks, the invitation of which was supported by the European Network of Excellence Photonics4Life. Niek van Hulst from the ICFO-the Institute of Photonic Sciences, Barcelona, gave a presentation on the preparation and properties of nanoantennas, which allow the detection of single fluorescent molecules and promise applications in nano-scale optical microscopy. Roberto Pini from the Institute of Applied Physics, Florence, introduced the surgical technique of laser welding employed for ocular tissues and presented a microscopic analysis especially of the modifications induced in collagen by the laser welding. Paul French from Imperial College, London presented a multitude of clinical applications of multi-dimensional fluorescence imaging including rapid fluorescence lifetime imaging. Francesco Pavone from the University of Florence presented examples where the use of second harmonic generation imaging is able to furnish information about the order of structures and the structural dynamics of molecules up to the atomic scale. Finally, Nimmi Ramanujam from Duke University, Durham, gave an overview of photonics based tools that can provide insights into the metabolic, physiologic, and morphological properties of breast tissue for translational applications in breast cancer.

The conference started with a session about the application of spectroscopic techniques for ophthalmology and cardiology including fluorescence lifetime imaging, e.g. for the differentiation of healthy tissue from that suffering from age-related macular degeneration, multimodal multiphoton imaging techniques for imaging the anterior segment of intact eye tissue and software evaluation methods for the hyperspectral characterization of atherosclerotic plaques. This session was followed by two sessions focusing on skin diagnostics. The presentations in these sessions were centered on the investigation of skin

cancer and precancerous stages employing multiphoton tomography, elastic scattering spectroscopy, diffuse reflectance, and fluorescence spectroscopy. Other presentations reported about the age determination of bruises and blood stains. The skin diagnostic sessions were followed by two sessions on biospectroscopy and point-of-care diagnostics. The first of these sessions concentrated on biochips and sensors for a variety of different applications, e.g. cardiac marker detection, detection of specific proinflammatory substances and the detection of apoptosis, but also fundamental aspects were covered like the optimal fabrication and tailoring of gold nano- and microstructures for the generation and employment of surface plasmon resonances for imaging applications. The second session was focused on different Raman spectroscopic techniques for such diverse applications as lowest drug concentration determination, localization and identification of bacteria and the investigation of biomaterials on a nanometer scale employing tip enhanced Raman spectroscopy. The minimally invasive diagnostics sessions were as diverse concerning the applications as with regard to applications. One main topic that could be identified was concerned with investigations of blood and blood oxygenation mostly with near infrared spectroscopy but also by employing the visible part of the spectrum. The two final sessions of the conference consisted of presentations about spectroscopy for clinical and preclinical tissue characterization. In the focus of most of the presentations was again cancer, especially breast cancer and a variety of other cancer types like pancreatic, cervix, and bladder cancer, to name just a few. The spectroscopic methods were applied for screening, biopsy as well as for tumor border delineation.

A majority of the presenters at the clinical and biomedical spectroscopy subconference of the ECBO submitted manuscripts which can be found on the subsequent pages. We hope that they will stimulate the reader to make her or his own contribution to this exciting and growing field within biophotonics.

Irene Georgakoudi
Jürgen Popp
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