Special section guest editorial: selected topics in biophotonics: optical coherence tomography and medical imaging using diffuse optics.

Andersson-Engels, Stefan; Andersen, Peter

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Selected Topics in Biophotonics: Optical Coherence Tomography and Medical Imaging Using Diffuse Optics

Stefan Andersson-Engels
Peter E. Andersen

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This special section comprises one invited tutorial review paper and several contributed papers from the summer school Biophotonics '11, as well as contributed papers within this general scope.

Motivation and Purpose of Biophotonics Graduate Schools

Over the past decade, lasers, optical methods, and instruments based on light interaction with tissues have emerged as powerful techniques for medical diagnostics, monitoring wide spectra of tissue function, and pathology. In biophysics and biology, optical sensing and manipulation of cells have strengthened understanding of basic cell function. Together with improved laser therapeutic techniques, optical sensing and cell manipulation form the basis for the increased interest in biophotonics. Throughout Europe, the U.S., and the rest of the world, major research centers are highly active in this field that, in a broad sense, may be labeled biophotonics. Therefore, education within this area is becoming increasingly important.

The main purpose of the biennial graduate summer school is to provide education in the field of biophotonics for students and young scientists at the highest international level. Our aim is to attract internationally renowned researchers as lecturers to attract the most talented young researchers worldwide in the field of biophotonics.

Format of the Biophotonics Graduate Summer School

The school mainly targets graduate students and postdoctoral fellows. The format of the school is a combination of lectures and student poster presentations, with time between lectures for discussions and exchange of scientific ideas. The lecturers cover one topic in a full session comprised of four lectures, which thoroughly covers the basics and state of the art of each topic. Although this format limits the number of topics taught at each school, the topics selected for the schools are covered in detail. Therefore, the range of topics taught will change from year to year.

An important feature of the summer school format is that students and lecturers spend the entire week together, which provides excellent opportunities for the exchange of scientific ideas, networking, and socializing.

The 5th International Graduate Summer School Biophotonics '11 covered the basics of lasers as well as supercontinuum sources and their application in medicine, tissue optics, photodynamic therapy, optical tweezers and their applications in biophotonics, optical biosensors, diffuse optical and molecular imaging, fluorescence nanoscopy, and optical coherence tomography.[1]

Special Section in the *Journal of Biomedical Optics*

We are pleased to introduce the contributions to this special section on Selected Topics in Biophotonics: Optical Coherence Tomography and Medical Imaging using Diffuse Optics, comprised of one invited tutorial paper and nine contributed papers, mainly from the participants of the school, but also from other researchers in the field. Not all the contributions are strictly covered by the title of the special section, but all of the contributions reflect the core topics of the school and span the fields of biomedical optics and biophotonics.

The invited tutorial paper, "Medical imaging using diffuse optics," is written by Bruce Tromberg, a lecturer at the school. This paper is tutorial in character and provides an excellent background to the field of diffusion imaging and spectroscopy. The paper provides a natural continuation to previous tutorial papers on the foundation of diffuse optics,[2] molecular imaging,[3] and photodynamic therapy,[4] which were published in the special sections from the previous summer schools in 2007 and 2009. These papers all belong to a planned series of tutorial review papers from each biennial school that provide high-level educational material for the benefit of the scientific community and, in addition, fulfill our own motivation for creating the school in the first place.

The contributed papers are discussed below according to their main topic, starting with papers categorized as contributions within diffuse optics. Chung et al. examine the tissue water content and molecular microenvironment as a means of intrinsic cancer contrast imaging. Diffuse optical spectroscopy imaging and magnetic resonance imaging are investigated. The method shows promise for bedside imaging applications. Mo et al. investigate tomographic imaging of a photosensitizer for photodynamic therapy, demonstrating their method in tissue-like phantoms as well as preclinical investigations in a mouse model.

The next group of papers spans another important biomedical imaging modality, i.e., optical coherence tomography (OCT). Bousi and Pitris propose a postprocessing deconvolution algorithm for improving the axial resolution in frequency-domain OCT. They obtain almost one order of magnitude improvement. Krstajic et al. propose a new concept for a common-path Fourier domain (FD) OCT system using the tissue surface itself as a reference arm. Encouraging results are presented. Unglert et al. investigate three optical imaging methods, including optical frequency domain imaging, spectrally encoded confocal microscopy, and full-field optical coherence microscopy, in order to visualize both architecture as well as cellular detail in lung tissue *ex vivo*. The aim is to further advance the understanding alveolar physiology and pathology. Ambrosi et al. use OCT to characterize tissue fiber orientation below the endocardial tissue surface. The study is important for the understanding of normal and abnormal cardiac conduction of the atrial pacemaker complex.

Burkhardt et al. present an optical design for a forward-imaging OCT endoscopic device and demonstrate its feasibility *ex vivo* as well as *in vivo* in by using a spectral-domain OCT system. Gaertner et al. show a multimodal approach for investigation of lung tissue by combining OCT with confocal fluorescence microscopy. Such an approach allows simultaneous recording of structural and functional information, which holds great promise for future applications.

Finally, Rahman et al. investigate the feasibility of a simple, low-cost fiber-optic scanning and imaging system. Their aim is to develop a system applicable in dentistry; hence, low cost and portability are important issues. Their *ex vivo* results show that their method holds good promise.

The special section finishes with three articles on different topics. The first of the contributions deals with optical mammographic tomography compensating for an angled chest wall in the reconstruction. The next paper presents a Raman spectroscopic study of an antimalarial drug, providing insight into the drug mechanism. Lastly Schelb et al. illustrate a fluorescence excitation method to be used with monolithically integrated all-polymer chips.

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Stefan Andersson-Engels, PhD
Lund University

Peter E. Andersen, PhD
Technical University of Denmark

Special Section Guest Editors