SYBO 1: Symposium Biomedical Optics 1

Time: Thursday 11:00–13:00 Location: e415

Invited Talk SYBO 1.1 Thu 11:00 e415

Recent advances of Optical Coherence Tomography — •Wolfgang Drexler — Zentrum für Medizinische Physik und Biomedizinische Technik, Medizinische Universität Wien

Optical coherence tomography (OCT) is one of the most rapidly emerging and innovative optical imaging modalities of the last decades enabling in vivo cross-sectional tomographic visualization of internal microstructure in biological systems. Recent developments in ultrabroad bandwidth laser as well as OCT technology enable three-dimensional ultrahigh resolution OCT with unprecedented axial resolution, approaching resolution levels of con-ventional histopathology, enabling optical biopsy of biological tissue. In addition, multimodal extensions of OCT are recently under development that should provide noninvasive depth resolved functional imaging of the investigated tissue, including extraction of spectroscopic, blood flow or physiologic tissue information. These extensions of OCT should not only enable subcellular resolution imaging, improve image contrast, but should also enable the differentiation and early detection of pathologies via localized biochemical, molecular properties or functional state. The hypothesis is to provide (sub)cellular level resolution visualization of tissue morphology (optical biopsy) and at the same time localized metabolic, molecular and physiologic tissue information in performing a single volumetric multimodal OCT measurement.

Invited Talk SYBO 1.2 Thu 11:30 e415

Vortex-beams for precise and gentle dissection in refractive corneal surgery — •Alfred Vogel, Sebastian Freidank, and Norbert Linz — Universität zu Lübeck, Institut für Biomedizinische Optik, Peter-Monnik-Weg 4, 23562 Lübeck

Vortex beams allow for efficient and precise corneal dissection in refractive surgery. Improved precision is important for LASIK, where excimer laser ablation of stromal material corrects the refractive error after the stroma has been exposed by creating and lifting a thin flap as well as for SMILE, where two intrastromal incisions produce a lenticule that is then removed with forceps through small side cuts. For dissection, ultrashort laser pulses are focused in a raster pattern into the corneal stroma and plasma-induced micro-explosions generate cavitation bubbles that cleave the corneal lamellae.

Cutting precision is compromised by the large focus length associated with commonly used IR wavelengths and moderate NAs. The donut-shaped, short focus of vortex beams largely improves the cleavage efficiency along the lamellae, which dramatically reduces the absorbed energy needed for cutting, diminishes bubble formation in the cutting plane as well as mechanical side effects, and leads to a smoother dissection. The new approach is investigated by high-speed photography with 50 Mio frames/s, ex-vivo tissue experiments, and SEM.

Invited Talk SYBO 1.3 Thu 12:00 e415

Structured Illumination and the Analysis of Single Molecules in Cells — •Rainer Heintzmann — Institute of Physical Chemistry and Abbe Center of Photonics, Helmholtzweg 4, 07743 Jena — Leibniz Institute of Photonic Techology, Albert Einstein Str. 9, 07745 Jena

In the past decade advances have been made in the field of microscopy imaging, which have been honored by the Nobel prize in Chemistry 2014. Another high-resolution method is based on transforming conventionally unresolvable details into measurable patterns with the help of an effect most people have already personally experienced: the Moiré effect. If two fine periodic patterns overlap, coarse patterns emerge. This is typically seen on a finely weaved curtain folding back onto itself. Another example is fast moving coarse patterns on both fences of a bridge above a motorway, when approaching it with the car. The microscopy method of structured illumination utilizes this effect by projecting a fine grating onto the sample and imaging the resulting coarser Moiré patterns containing the information about invisibly fine sample detail. With the help of computer reconstruction based on several such Moiré images, a high-resolution image of the sample can then be assembled. Another way to obtain a high-resolution map of the sample is to utilize the blinking behavior inherent in most molecules, used to stain the sample. Methodological advances (Cox et al., Nature Methods 9, 195-200, 2012) enable us to create pointillist high-resolution maps of molecular locations in a living biological sample, even if in each of the required many individual images, these molecules are not individually discernible.

Invited Talk SYBO 1.4 Thu 12:30 e415

Biophotonics - a potential solution to unmet medical needs!? — •Juergen Popp — Leibniz Institute of Photonic Technology, Jena, Germany — Institute of Physical Chemistry & Abbe-Center of Photonics, Friedrich-Schiller University Jena, Germany

Understanding the cause of diseases, early disease recognition, targeted disease treatment, predication of therapeutic response and monitoring treatment success; are the underlying principles of the vision associated with modern biomedicine. In the past years biophotonics has witnessed the development of optical / photonic approaches that are potentially in a position to meet these aforementioned unmet medical needs. In this context spectroscopic approaches like e.g. Raman spectroscopy are especially noteworthy. We will show, that Raman spectroscopy holds great promise as point-of-care approach for a fast identification of pathogens and the determination of their antibiotic resistances, which is crucial for patient*s survival. Furthermore, it will be shown that the combination of Raman approaches with other spectroscopic technologies provides a sensitive and selective diagnostic tool for tissue analysis, i.e. spectral histopathology. We will introduce a combined Raman /FLIM (fluorescence lifetime imaging microscopy) fiber optical probe for in-vivo tissue screening. Furthermore we demonstrate how the combination of CARS (coherent anti-Stokes Raman scattering), SHG (second harmonic generation) and two-photon excited autofluorescence (TPEF) enables the fast and label-free characterization of the morphochemistry of frozen section biopsy specimens and therefore represents high potential for an intraoperative frozen section analysis.