SYLM 1: Laser in der Medizin I

Zeit: Dienstag 14:00–16:00 Raum: GW1 HS

Hauptvortrag SYLM 1.1 Di 14:00 GW1 HS

Mechanisms of plasma-mediated surgery of cells and tissues — •Alfred Vogel, Xiao-Xuan Liang, Sebastian Freidank, and Norbert Linz — Institute of Biomedical Optics, University of Luebeck, Germany

Laser-induced plasma generation and plasmonics are used for intraocular, refractive and cataract surgery as well as for gene transfection into cells and for targeted effects via antibody-conjugated nanoparticles. We investigated the sequence of events from plasma formation through acoustic emission, bubble formation and subsequent bubbles oscillations both experimentally and theoretically for bubble sizes in the micrometer and nanometer range. Photographs of luminescent plasmas and transmission measurements allowed for determining the plasma energy density, and interfereometric measurements enabled us to record the bubble dynamics in single-shot measurements with nanometer accuracy and 160 ps time resolution. These experimental data provide the input for a model that tracks energy flow and partitioning, as well as pressure evolution and shock wave emission from plasma formation throughout the entire bubble life time. Changes associated with decreasing bubble size will be demonstrated, and consequences for biomedical applications discussed.

Hauptvortrag SYLM 1.2 Di 14:30 GW1 HS

Fourier Domain Mode Locking (FDML): A new laser for Optical Coherence tomography (OCT) and molecular microscopy — •Robert Huber — Institut für Biomedizinische Optik, Universität zu Lübeck, Peter-Monnik-Weg 4, 23562 Lübeck

Optical coherence tomography (OCT) is one of the biggest and fastest growing fields in optics. This new optical imaging modality is mainly used in biomedical applications, where it can provide depth resolved three-dimensional tissue contrast with micron scale resolution. One implementation of OCT requires rapidly wavelength swept, narrowband cw-laser light sources. Since the performance requirements of such OCT lasers substantially differ from classical tunable lasers, many groups have spent great effort over the last ten years on developing appropriate laser sources. Some of the best performing OCT light sources are the recently developed Fourier Domain mode locked (FDML) lasers, which enabled OCT depth scan rates well into the Multi-Megahertz range (MHz-OCT) for the first time. The talk will discuss the FDML mechanism, the related physics behind it, the involved laser technology, and various OCT imaging examples. Finally, recent results on using a FDML in combination with a new class of nanosecond fiber lasers for stimulated Raman sensing and two-photon imaging will be presented.

Hauptvortrag SYLM 1.3 Di 15:00 GW1 HS

Kompakte durchstimmbare Kurzpulsfaserlaser für die kohärente Raman Mikroskopie — •Tobias Meyer[1,2], Thomas Gottschall[3], Thomas Bocklitz[1,2], Michael Schmitt[2], Jens Limpert[3,4], Andreas Tünnermann[3,4] und Jürgen Popp[1,2] — [1]Leibniz Institute of Photonic Technology (IPHT) Jena e.V., Albert-Einstein-Str. 9, 07745 Jena, Germany — [2]Institute of Physical Chemistry and Abbe Center of Photonics, Friedrich-Schiller University Jena, Helmholtzweg 4, 07743 Jena, Germany — [3]Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller University Jena, Albert-Einstein-Str. 15, 07745 Jena, Germany — [4]Fraunhofer Institute for Applied Optics and Precision Engineering, Albert-Einstein-Str. 7, 07745 Jena, Germany

Die kohärente Raman-Mikroskopie, d.h. die stimulierte Raman Streuung und die anti-Stokes Raman-Streuung, ermöglicht die Visualisierung der Verteilung aller molekularer Marker in Gewebe. Obwohl das für viele biomedizinische Anwendungen sehr interessant ist, werden die Methoden bisher überwiegend in der Grundlagenforschung eingesetzt, da die erforderlichen durchstimmbaren Mehrfarb-Kurzpulslasersysteme nicht kliniktauglich sind. In diesem Beitrag werden neue faserlaserbasierte Konzepte zur Frequenzkonversion in photonischen Kristallfasern vorgestellt, mit denen sich kompakte luftgekühlte Laser realisieren lassen. Potentielle medizinische Anwendnungen wie die färbefreie Histopathologie von Gewebe basierend auf multimodaler nichtlinearer Mikroskopie und die intraoperative Tumorranderkennung werden vorgestellt.

Hauptvortrag SYLM 1.4 Di 15:30 GW1 HS

Photons fight against pathogenic bacteria — •Wolfgang Bäumler — Department of Dermatology, University of Regensburg, Germany

Photodynamic inactivation of bacteria proves to be an innovative, alternative method to kill pathogenic bacteria. In the photodynamic process a photosensitizer molecule absorb light, populates thereby its triplet T1 state via intersystem crossing, and subsequently transfer the energy from T1 state to adjacent oxygen molecules to generate reactive oxygen species (ROS). Among ROS, the so-called singlet oxygen is generated, which is the energetically lowest excited state of molecular oxygen. Singlet oxygen causes oxidative damage of important biomolecules (lipids, proteins) in living cells like bacteria. Such cells are killed in case of sufficiently high number of singlet oxygen molecules. Due to the short lifetime, singlet oxygen should be generated close to bacteria. This is accomplished by cationic photosensitizer molecules which can attach to the negatively charged surface of bacteria. Singlet oxygen production in solution or bacteria can be proven by time- and spectral resolved detection of its luminescence at 1270 nm. To allow broad application, photosensitizers should be safe when applied in humans. Natural substances like vitamin B2 or Phenalenone are known to produce singlet oxygen upon irradiation with high quantum yields of about 75% to 98%. Different bacteria can be effectively killed with PIB with up to 6 log10 steps.