

Laser technologies in biophotonics and biomedical applications

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This and the next issues of Quantum Electronics present the articles reflecting the state of the art of laser technologies in biophotonics and biomedical research. Quick progress in laser biomedical diagnostics and therapy is based to a large extent on the development of new laser and optoelectronic technologies, means of delivery of laser radiation to the research or application sites, as well as of the detection and imaging devices. In addition, significant progress in the development of computational techniques and nanotechnologies enabled the researchers to obtain novel, previously unachievable information on the living objects and to ensure more efficient influence of light on selected structures.

Optics of nanoparticles with a plasmon resonance and its applications in biosensorics and biomedicine form a new field of nanobiotechnologies and biophotonics referred to as nanoplasmonics. A number of articles in this special issue are devoted to the application of nanoparticles and nanotechnologies in biophotonics and biomedical studies.

The possibility to generate narrowband highly coherent radiation and broadband radiation with a short coherence length forms the basis of the methods of correlation and Doppler spectroscopies, laser interferometry and optical coherence tomography (OCT). These methods are efficiently used to study the dynamic and structural characteristics of normal and pathologically modified biological objects. In particular, extensive research conducted during the last few years has demonstrated the high perspectives of OCT application for such studies. Articles devoted to the coherent methods of studying biotissues are widely represented in this special issue.

Diffuse optical tomography (DOT) is now one of the most important diagnostic tools based on the application of optical methods. One of the articles of the special issue is devoted to the development of a specific DOT algorithm, namely the method of mean photon trajectories.

The methods of laser spectroscopy give important information on the structure and functions of different

tissues of the human organism. This issue presents papers devoted to the diagnostics of pigmented skin tumors by the methods of laser-induced autofluorescence and diffuse reflectance spectroscopies, as well as to the application of IR laser radiometry to the study of thermal and optical properties of polyacrylamide hydrogels and cartilages.

To provide the reliable layer-by-layer dosimetry of probing laser radiation, novel contemporary methods of computer analysis of experimental data should be developed. In addition, far from all the parameters determining the properties of biological objects and the propagation of laser radiation inside them can be measured experimentally. In this respect, the application of methods of numerical simulation of laser radiation transfer in biological tissues gains growing importance. A number of articles in this issue are related to the application of the Monte Carlo method in biomedicine. Numerical simulations demonstrated the possibility of increasing the efficiency of laser removal of tattoos by means of optical clearing of skin, revealed the role of multiple scattering in the formation of the OCT images, and showed that artificial neural networks can be used to restore the image of the internal structure of random media by the spatial characteristics of backscattered optical radiation.

Studies of light scattering by cells, e.g. red blood cells, cell aggregates, microorganisms and other particles is one of the basic problems of biomedical optics. In this respect, one of the articles of this issue develops a theoretical model and proposes an algorithm for fast calculations of light scattering by a transparent dielectric particle of size highly exceeding the light wavelength.

The majority of papers included into the special issue were presented at the XI annual International multidisciplinary school for young scientists and students on optics, laser physics and biophysics held in Saratov, Russia, 25–28 September 2007, which was attended by more than 500 specialists from 20 countries of the world. The editors of the special issue hope that all articles included into the issue will be of interest to many readers of Quantum Electronics.

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