Editorial

Introduction to the Special Issue “ICPPP-20”

July 7–12, 2019, Moscow has hosted the jubilee, 20th International Conference on Photoacoustic and Photothermal Phenomena, ICPPP-20. It provided comprehensive coverage of the basic studies and applied research in the field of photoacoustics–optoacoustics–thermoacoustics. Following traditions of this popular conference series, the topics of ICPPP-20 included the fields of imaging, sensing, and monitoring, bi- and nanophotonics, laser medicine and theranostics, nondestructive testing and evaluation, photo-thermo-physics, materials science, analytical and physical chemistry. This Special Issue is a collection of papers based on technical reports presented at the conference.

The focus on photothermal and photoacoustic studies has recently shifted to applications in biology and medicine. Optoacoustic imaging systems recently entered mainstream medicine, which resulted in a bloom of instrumental solutions, the development of new applications, and innovative basic research. This Special Issue illustrated this direction by the paper “Optical clearing for photoacoustic lympho- and angiography beyond conventional depth limit in vivo” by Novoselova and coauthors. This research provides a way to increase the penetration depth and image quality with raster-scanning optoacoustic mesoscopy (RSOM) using techniques of the optical clearing of tissues to map vessels and lymph nodes. This paper is an example of an advanced level of RSOM studies applied to noninvasive 3D visualization and quantitative analyses of live tissues, which can also expand to other biomedical applications.

This Special Issue also contains papers associated with the utilization of optoacoustic imaging instrumentation in the fields of cell biology and Earth sciences. The article “Photoacoustic and photothermal lifetime imaging of diatoms” by Cvjetinovic and coauthors is one of the first papers on single-cell organism imaging using methods of photoacoustics. It deals with the combined use of photoacoustic and fluorescence imaging techniques for diatom algae to visualize and quantify cell colonies in natural media. Like many biomedical applications of RSOM, this does not require complex sample-preparation procedures, is readily scalable, and probably forms a new trend in photoacoustic applications.

Interferometer-based photoacoustics that stayed in the shadow of laser-based techniques, has received a boost with several new successful practical applications. This technique has the potential in many experimental studies that require chemical selectivity. The paper “FTIR photoacoustic spectroscopy for identifying and assessing soil components: Chernozems and their size fractions” by Krivoshein and coauthors describes this modality for soil analysis. Optimization of the photoacoustic measurement conditions and the methods of chemical analysis provides detailed information on such complex samples and allows one to differentiate soil samples of similar composition. This article is complemented by the review paper “Photoacoustic and photothermal methods in spectroscopy and characterization of soils and soil organic matter” by Volkov and coauthors. It summarizes the potential and the achievements of the analytical methods including laser-based single-channel techniques, interferometer-based IR modalities, and multispectral techniques based on cantilever technologies for studies of solid soil and mineral samples.

The paper entitled “Toroidally focused sensor array for real-time laser-ultrasonic imaging: The first experimental study” by Bychkov and coauthors describes a new laser ultrasound system for applications in nondestructive evaluation and testing. Various laser-based ultrasonic imaging designs have been developed for a long time, and recently achieved a new level of depth profiling and spatial resolution. This paper shows the possibility of attaining a submillimeter lateral resolution for real-time ultrasonic and photoacoustic images using a toroidally focused imaging system. This paper is somewhat complemented by the contribution entitled “Modelling of open photoacoustic resonators” by El-Busaidy, which provides a simulation of a promising detection system for solid samples. These two papers may serve as a backbone for various applications of photoacoustic and photothermal techniques in industrial applications and biomedicine.

The papers in this Special Issue cover the diverse range of subjects discussed at ICPPP-20 and represent valuable contributions to the field of photoacoustic and photothermal phenomena. We hope that these works will be also interesting for the readers from research communities.

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