

XIII International Symposium „Optics and Biophotonics“ (Saratov Fall Meeting 2025), Saratov, September 30–October 3, 2025.

Saratov Fall Meeting, the International School-Conference on Optics, Laser Physics and Biophotonics, has been held every autumn in Saratov on the venue of Chernyshevsky Saratov National Research State University for over 29 years. During this time, the scientific symposium „Optics and Biophotonics“ was formed into a separate structure, which in 2025 was held for the thirteenth time. The SFM-25 program can be found at <https://sfmconference.org/files/program-of-sfm25-crw-25-brics-25.pdf>.

This issue of the Journal of Technical Physics includes selected papers based on reports presented at five of the fifteenth events of the symposium:

- Workshop on Laser Physics and Photonics XXIV
- Conference on Low-Dimensional Structures XV
- Workshop on Electromagnetics of Microwaves, Submillimeter and Optical Waves XXV
- Conference on Spectroscopy and Molecular Modeling XXVI
- Conference on Nanobiophotonics XXI

The articles based on the reports presented at these workshops and conferences are closely interrelated in terms of subject and nature of the tasks. Graphene, carbon nanotubes, fullerenes, metamaterials, nanocomposites, and nanostructures are widely represented among the objects of research. The research methods include a variety of applications of laser radiation for both active exposure and non-invasive diagnostics. The fundamental studies outlined in most articles are aimed at achieving applied and technological goals, among which, first and foremost, biomedical applications stand out. Without claiming to reflect the program of the Symposium as a whole, the topics of the articles in this issue highlight both the activity of the authors and the real trends in the modern physics development discussed.

Let's illustrate the aforesaid with some examples. Graphene is the subject of the largest number of articles in this issue, both theoretical and applied. The nonlinear electromagnetic response of graphene in the strong coupling model (M.V. Davidovich), the diffraction of monochromatic waves and ultrashort pulses on graphene gratings in a magnetic field (A.M. Lerer, G.S. Makeeva, I.N. Ivanova, V.I. Kravchenko) were theoretically described, and semi-classical and quantum radiation in graphene under the influence of a step field (V.V. Dmitriev, D.V. Churochkin, V.A. Tseryupa, S.A. Smolyansky) were investigated. In some papers, graphene was studied as a component of more complex systems, e.g., two-dimensional graphene/LiCoO₂ films, for which the impact of the mass fraction of carbon

on the quantum capacitance was studied (V.V. Shunaev, A.A. Petrunin, O.E. Glukhova), as well as quasi-two-dimensional graphene-nanotube films with its electrophysical characteristics analyzed depending on the metal oxide nanoparticles effect (M.M. Slepchenkov, P.V. Barkov, S.G. Levitsky, O.E. Glukhova). Among the application studies using graphene, we should mention the development of laser-induced dry electrodes based on carbon nanotubes and graphene for ECG registration (A.V. Kuksin, A.S. Morozova, Yu.O. Vasilevskaya, A.Yu. Gerasimenko), as well as an experimental study of the structure formation and resistivity of hydrogels during photopolymerization with the introduction of carbon nanotubes and reduced graphene oxide (M.S. Saveliev).

Along with graphene, a significant part of the articles sheds light on research and applications of other carbon structures, such as nanotubes and fullerenes. We have already mentioned the studies where carbon nanotubes were considered along with graphene or as part of graphene-nanotube films. The results of theoretical studies of the functionalization of the pure carbon nanotubes by copper and nickel atoms (N.P. Boroznina, D.F. Sergeev, S.V. Boroznin, I.V. Zporotskova) are also presented, which made it possible to determine the optimal positions of copper and nickel atoms on the surface of a carbon nanotube in terms of improving its conductive properties. In the article by N.G. Yanushkina, the dynamics of extremely short optical pulses in a composite medium based on polymer and carbon nanotubes is theoretically investigated given the impact of external alternating electric field, through which the amplitude, shape and speed of pulse propagation can be effectively controlled. Among the applied experimental works, it is necessary to mention the development of nanocomposite biointerfaces based on carbon nanotubes for seamless restoration of blood vessels. A team of authors (V.V. Suchkova, I.N. Sorokvasha, K.D. Efremova, D.I. Ryabkin, E.V. Blinova, D.V. Telyshev, S.V. Selishchev, A.Yu. Gerasimenko) with the participation of employees of leading medical centers of the Russian Federation obtained *in vivo* the experimental results on laboratory animals demonstrating the potential of this technology for further optimization and clinical implementation. It is reported about fabrication of multiscale nanomaterial structures to create passive and active implantable devices that stimulate nerve tissue through the use of laser microstructuring and the use of carbon nanotube coatings (D.T. Murashko, K.D. Efremova, B.M. Putrya, E.M. Eganova, A.Yu. Gerasimenko). An important applied result is also the modification of titanium surfaces for biomedical electronics

in order to improve electrophysical properties by forming conductive coatings based on single-walled carbon nanotubes (K.D. Efremova, E.A. Kuznetsova, P.N. Vasilevsky, S.V. Selishchev, A.Yu. Gerasimenko).

Nanoparticles and nanostructures in these articles are studied in connection with a wide range of applications, primarily of a biomedical nature. This group of works primarily includes the study of the morphology and biocompatibility of plasmonic gold and silver nanoparticles for engineering of biointerfaces (U.E. Kurilova, D.V. Novikov, Yu.V. Chumachenko, A.M. Tarasov, S.V. Dubkov, D.G. Gromov, I.A. Suetina, L.I. Russu, M.V. Mezentseva, A.Yu. Gerasimenko), formation of thin films of electrically conductive laser modified carbon nanostructures for ultrasensitive biocompatible strain gauges designed to register obstructive sleep apnea syndrome (A.S. Morozova, A.Yu. Gerasimenko). It is suggested to obtain composite iron and gold nanoparticles using a new three-stage synthesis method based on a combination of femtosecond laser ablation and ultrasound exposure (A.S. Chernikov, D.A. Kochuev, R.V. Chkalov, M.A. Dzus, E.I. Shingareva, K.S. Khorkov). To a certain extent, this includes a comparative experimental study of heterophase film samples of CdS:Fe obtained by different methods (P.G. Kharitonova, S.V. Stetsura), since the observed differences in photovoltaic properties are associated with a different arrangement of nanorameric inclusions of FeS.

The laser theme included not only technological applications of lasers, but also development of theoretical methods for describing laser radiation in new types of media. The successful application of laser technologies for the production of components for millimeter-range vacuum electronic devices is reported (D.A. Nozhkin, D.A. Bessonov, I.A. Navrotsky, R.A. Torgashov, V.D. Churikova, S.Yu. Molchanov, I.S. Ozhogin, A.A. Ros-tuntsova, N.M. Ryskin). The development of a complex for the fabrication of metasurfaces by laser-induced forward transfer (LIFT) method using a system for independent movement of donor-acceptor substrates is presented (D.A. Kochuev, A.S. Chernikov, R.V. Chkalov, K.S. Khorkov, M.Yu. Gubin, A.V. Shesterikov, A.V. Prokhorov). The proposed complex and methodology ensure stable formation of metasurfaces with precise positioning and period control. Laser methods for probing the complex media are highlighted as findings of experimental studies of the evolution of model samples of gas-liquid foams using the speckle correlometry method under low-frequency acoustic exposure and in the absence of such exposure (E.A. Isaeva, A.A. Isaeva, D.A. Zimnyakov). The quantum-optical topic, which is no less traditional for the Symposium, is represented by an exact solution of the Liouville quantum equation for a model consisting of three identical two-level atoms (qubits) A, B and C and two independent resonators (A.R. Bagrov, E.K. Bashkirov). It is shown that during the evolution process, qubits never transit to the states formed at the initial moment of time, which is fundamentally different from the three-qubit models studied previously.

Molecular dynamics and spectroscopy are represented by works of both fundamental methodological and purely applied nature. A new modification of the density functional method with self-consistency field with respect to charge (SCC DFTB) in the tight-binding approximation has been developed, within which the newly obtained set of Slater-Koster basis functions demonstrates a more accurate reproducibility of metric parameters of a lattice when compared with reliable data from experimental studies (P.A. Kolesnichenko, O.E. Glukhova). Using density functional theory methods, the IR bands of stretching vibrations of water molecules and their deuterium analogues in complexes with triacetin were theoretically studied, and molecular models of the triacetin dimer with different types of hydrogen bonds were constructed (K.V. Berezina, E.Yu. Stepanovich, K.N. Dvoretzky, E.M. Antonova, A.M. Likhter, I.Yu. Yanina). The findings prove the experimental observations of the structure and dynamics of hydrogen bonds in triglyceride-water systems, contributing to the understanding of fat hydration. Finally, the variations in the Raman spectra of bone tissue, which are indicators of diagenetic transformations, for absolute dating of archaeological material has been demonstrated (D.V. Abramov, O.V. Danilov, V.A. Bykova, K.M. Stankevich, K.S. Khorkov), the accuracy of which is comparable to generally accepted methods already at this preliminary stage of the study.

Even from the very brief description of the studies included in this issue, the pronounced multidisciplinary nature of the presented research is evident. It is not surprising that publication in the Journal of Technical Physics best suits the goals and spirit of our symposium. The organizers of the symposium express their deep gratitude to the editors of the journal for publishing the works and to all the authors for their active participation in the preparation of this issue. We gratefully acknowledge the extensive efforts from the reviewers, whose substantial comments helped to significantly improve the quality of the submitted manuscripts.

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Chair of the Symposium Organizing Committee

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