

FEMTOSECOND TECHNOLOGIES

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Femtosecond technologies

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The last decade has seen a rapid development of one of the promising scientific and engineering fields of the XXI century – femtosecond optics and laser femtotechnology. On the one hand, this is due to the advances of laser physics in the generation of ultrashort optical pulses with a duration of less than 10 fs (10^{-14} s) and, on the other, due to the unique possibilities that femtosecond optics opens up for a broad range of applications. Among these are controlling the processes in physical, chemical, and biological systems at atomic and molecular levels, high-capacity information technologies, precision microprocessing of materials, femtosecond metrology, etc.

It should be emphasised that femtosecond optics underlies the advancement of another realm of strategic significance – the physics of ultrastrong fields and extreme states of matter produced by these fields. Such fields may be generated by ultrashort-pulse laser sources with peak intensities of the terawatt (10^{12} W) and, in the near future, the petawatt (10^{15} W) level. At the front line of this investigation are US research centres. The first petawatt laser system was built in the Lawrence Livermore National Laboratory in 1998. Its estimated production cost exceeded $100 million. The development of petawatt lasers costing dozens of millions of dollars now is underway in France, Germany, Great Britain, and Japan.

In Russia, there exist several traditionally potent scientific schools in Moscow, Nizhnii Novgorod, St. Petersburg, and Novosibirsk. They conduct priority research in the fields of femtosecond laser physics, the physics of ultrastrong optical field – matter interactions and extreme states of matter, femtosecond three-dimensional optical memory and optical tomography, femtochemistry, and biology, precision femtosecond spectroscopy and femtosecond metrology. In recent years, due to a very limited financing of the basic and applied Russian science, there emerged serious difficulties in retaining the front-line position in this field. Also observed is an ever-increasing time lag in the field of modern femtotechnologies. In this connection, the Scientific Council on Optics and Laser Physics of the Russian Academy of Sciences decided to organise a special scientific session on this problem.

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A guest session of the Scientific Council on Optics and Laser Physics, Russian Academy of Sciences, was held at the Institute of Applied Physics, RAS (Nizhnii Novgorod) during 7–8 December 2000. A seminar on 'Ultrafast processes in materials and laser femtotechnologies' was conducted within the framework of the session.

The main objective of the seminar was to estimate the present state and the prospects for developing femtophysics and femtotechnology in Russia and to determine the ways for combining different groups to retain the leading position of Russian science in the world. The seminar was organised by M V Lomonosov Moscow State University, Institute of Applied Physics, RAS (Nizhnii Novgorod), and Institute of Laser Physics, Siberian Division, RAS (Novosibirsk). The seminar was co-sponsored by the Ministry of Industry, Science, and Technologies of the Russian Federation and the Spectra Physics Laser Co. (USA). Over 50 specialists participated in the two-day seminar. Sixteen papers were presented on the following topics: femtosecond laser systems, precision femtometrology and femtotechnologies, and ultrafast processes in matter. A round-table discussion brought to a close the activities of the session.

It is pertinent to emphasise that this seminar came to be essentially the first Russian workshop on femtosecond laser optics, the ultrastrong electromagnetic field – matter interaction physics and femtotechnologies, whereas international workshops and conferences of this kind have been conducted on a regular basis 1–2 times a year for several years. Nevertheless, as noted by the participants, the scientific level of the papers presented at the session proved to be high enough. At least they were comparable to those presented at such prestige international conferences as CLEO.

At its final sitting, the Scientific Council decided to annually conduct a workshop on 'Ultrafast processes in materials and laser femtotechnologies.' Also accepted was the proposal to initiate in the highest instances the development of collective-use centres on the basis of femtosecond laser complexes at the International Laser Centre of the MSU and the Institute of Applied Physics, RAS.

In this issue of 'Quantum Electronics' eight papers are published, which were written in accordance with reports presented at the workshop in Nizhnii Novgorod. The papers were selected by S N Bagayev and V M Gordienko on behalf of the Scientific Council on Optics and Laser Physics.