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**CONFERENCE. A REVIEW**

# IV International Conference on Amorphous and Microcrystalline Semiconductors

## (July 5–7, 2004)

**E. I. Terukov^ (Chairperson of the Organizing Committee of the Conference)**

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The IV International Conference on Amorphous and Microcrystalline Semiconductors was held in St. Petersburg on July 5–7, 2004. This conference was organized by the Ioffe Physicotechnical Institute of the Russian Academy of Sciences and the Center for Scientists (at Lesnoe, near St. Petersburg) at St. Petersburg State Polytechnical University. The chairperson of the organizing committee was E.I. Terukov; the members of the organizing committee were K.D. Tséndin, Yu.A. Nikolaev, and I.N. Trapeznikova.

There were 198 papers presented at the conference. The participants included scientists from France, Bulgaria, Canada, Great Britain, India, Mexico, Japan, Latvia, and a number of scientists from the Commonwealth of Independent States (Ukraine, Belarus, Kazakhstan, Moldova, Azerbaijan, and Uzbekistan).

The traditional "Kolomiets lecture," entitled "Laser-Induced Structural Changes in Te-based Chalcogenides: Physics and Applications," was delivered by A.V. Kolobov (Center for Applied Near-Field Optics, National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan). In this lecture, extremely interesting and detailed data on the processes of writing information onto carriers composed of vitreous chalcogenide semiconductors were reported. During the plenary session, the lectures were delivered by leading scientists in the field of unordered semiconductors and included reviews of the latest achievements in the physics of the vitreous chalcogenide, amorphous, and organic semiconductors. The lecture delivered by N.V. Bodyagin (Ryazan State Academy of Radio Engineering) dealt with the development of alternative approaches to controlling the growth parameters of amorphous semiconductors taking into account the internal dynamic processes in the material. The lecture by A.S. Komolov (the Fock Research Institute of Physics at St. Petersburg State University) was concerned with analysis of the photovoltaic properties of films of copper phthalocyanine and certain organic semiconductors. The lecture by K.D. Tséndin (Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg) focused on the superconductivity effect and the role of defects in chalcogenide vitreous semiconductors. The lecture by É.N. Voronkov (Moscow Power Engineering Institute) was dealt with simulation of the breakdown dynamics in vitreous semiconductors. The lecture by Jean-Paul Kleider (L.G.E.P.–SUPERLEC, CNRS, France) was concerned with study of the energy-band states in amorphous or microcrystalline silicon and its alloys using a modulated photocurrent. Finally, the lecture by P.P. Seregin (St. Petersburg State Polytechnical University) was concerned with study of the order–disorder transition in the electronic subsystem of a semiconductor.

The scope of the conference encompassed the following seven topics, which were considered in special sessions:

(1) amorphous hydrogenated silicon and its alloys;

(2) amorphous and diamond-like carbon and other wide-gap semiconductors;

(3) microcrystalline and nanocrystalline semiconductors;

(4) organic semiconductors;

(5) chalcogenide and vitreous semiconductors;

(6) technical applications;

(7) accompanying materials.

In the papers devoted to amorphous silicon (*a*-Si), a great deal of attention was given to various technologies for fabricating amorphous films and to the interrelation between methods of fabricating the films and characteristics of the impurity- and defect-related states that affect physical properties such as electrical conductivity, luminescence, and optical absorption. Special attention was given to the papers delivered by A.G. Kazanskiĭ (Moscow State University), A.I. Kosarev (Institute Nacional for Astrophysics, Optics, and Electronics; Puebla; Mexico), M.V. Stepikhova (Institute of the Physics of Microstructures, Russian Academy of Sciences, Nizhni Novgorod), V.Yu. Timoshenko (Moscow State University), and A.V. Medvedev (Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg).

The paper delivered by A.G. Kazanskiĭ focused on theoretical and experimental studies of photoconductivity in microcrystalline silicon (μ*c*-Si). The results of

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experimental studies on the photoconductivity in μ*c*-Si:H films were considered. The magnitude of the photoconductivity was studied in relation to the material's structure (the ratio between the crystalline and amorphous phases), the photon energy of the excitation radiation, temperature, the level of doping with donor and acceptor impurities, and the defect concentration. The experimental data were analyzed taking into account the existing models for recombination of nonequilibrium charge carriers in μ*c*-Si:H and the multiphase structure of the material. It was shown that it is possible to use the formalism developed for *a*-Si:H to interpret data on the photoconductivity in μ*c*-Si:H.

The paper delivered by S.M. Manakov (Al'-Farabi Kazakhstan National University, Almaty) was of great interest. This paper was concerned with the search for unconventional and ecologically harmless sources of gaseous silicon hydrides that can be used in semiconductor electronics for obtaining doped layers of crystalline and amorphous silicon.

Studies related to the development of a material for electroluminescent and laser structures that emit at a wavelength of 1.54 μm retained their importance. Among the papers devoted to this field, a great deal of attention was given to the paper delivered by A.V. Medvedev, concerned with the tenfold increase in the intensity of erbium-related spontaneous emission with energy close to the edge of the optical band gap in a one-dimensional periodic structure based on amorphous silicon, grown by plasma-assisted chemical deposition, and doped with erbium during growth.

The paper delivered by M.V. Stepikhova was also of much interest. This paper was concerned with studies of the luminescent properties of low-dimensional silicon structures. It was shown that the most intense luminescence, whose intensity exceeds the intensity characteristic of crystalline silicon by a factor of 2, is observed for structures with the lowest degree of crystallinity and nanocrystal sizes of 1–3 nm.

Similar problems were solved in the paper delivered by B.Yu. Timoshenko, which was concerned with studying the effect of inhomogeneity in the dielectric constant of a solid-state matrix on the width of the spectrum of erbium-related photoluminescence for structures with *nc*-Si/$SiO_2$. The established, and extremely efficient, enhancement of erbium-related photoluminescence (PL) and the possibility of controlling the PL characteristics by varying the sizes of the nanocrystals provides fresh opportunities for the use of erbium-doped *nc*-Si/$SiO_2$ structures in silicon-based optoelectronics.

The participants of the conference gave a lot of attention to problems related to the technology involved in obtaining microcrystalline and nanocrystalline semiconductors and alloys and to the study of their properties. The interest in these materials is caused, on the one hand, by their high optical stability and, on the other hand, by new dimensional effects. In the corresponding session, keen interest was manifested in the paper delivered by M.D. Efremov (Institute of Semiconductor Physics, Siberian Division, Russian Academy of Sciences, Novosibirsk). This paper dealt with the Coulomb blockade in the case of single-electron charging of a silicon quantum dot in the structure of single-electron states using, as an example, silicon oxide films with incorporated silicon nanocrystals. This composite material is now considered to be promising in relation to the fabrication of single-electron transistors and memory elements in which a floating gate is replaced by nanocrystalline silicon inclusions. The size of the nanocrystals (several nanometers) and their high density make it possible to achieve terabit memory, which has generated a particular interest in this object. The above properties, in addition to the photoluminescence observed in these films, can be extremely important for the development of next-generation devices in single-electron and single-photon nanoelectronics.

In the papers concerned with amorphous carbon and other wide-gap semiconductors, methods for obtaining and studying these materials were considered; in addition, attention was given to theoretical simulation of the properties of the materials under consideration. The attention of the participants was particularly attracted to the paper delivered by A.L. Talis (All-Russia Research Institute of Synthesis of Mineral Raw Materials, Aleksandrov, Russia), which was concerned with new studies on the structure of diamond-like carbon and a local approach to adequate description of the symmetry of four-coordinated structures in a condensed state (from nanostructures to quasi-crystals and crystals). A number of papers were devoted to the search for promising new materials based on the carbon matrix for various applications. These papers included that delivered by B.P. Popov (St. Petersburg State Polytechnical University), which was concerned with studies of the electron spin resonance in copper–carbon systems with intercalated metals and metallic clusters; the paper delivered by É.A. Smorgonskaya (Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg), focused on modification of *a*-Si:H with metals (Co, Cu, Mo, Ni) with the aim of forming new solid-state structures possessing a high density of metallic nanoclusters; and the paper delivered by É.I. Tochitskiĭ (Plasmotekh Engineering Center of the Belarussian Academy of Sciences), which was concerned with the development of methods for fabricating nanosized high-strength thin-film materials with controllable electrical properties and a high adhesion to substrates formed from various materials at a low condensation surface temperature. Much interest was aroused by the paper delivered by V.I. Berezkin (Research Center of Ecological Safety, Russian Academy of Sciences, St. Petersburg), which was concerned with studying the mechanisms of adsorption of organic compounds at crystalline fullerenes, and by that delivered by V.V. Sobolev (Izhevsk State University, Russia), which was on the electronic structure of fullerites.

In the session devoted to organic semiconductors, most of the discussion was on polymeric semiconductors that can find application in solar power engineering and microelectronics. The participants of the conference displayed keen interest in the review paper delivered by V.V. Shamanin (Institute of Macromolecular Compounds, Russian Academy of Sciences, St. Petersburg), which dealt with the preparation and systematic physicochemical study of a new class of organic compounds, i.e., homoconjugated organometallic polymers that exhibit clearly pronounced semiconductor properties, namely, photoconductivity, photoluminescence, and relatively high charge-carrier mobility. These polymers are also of interest for the development of thin-film organic light-emitting diodes, field-effect transistors, and solar cells with new mechanisms of charge and electronic-excitation transport.

Among the papers on chalcogenide and vitreous semiconductors, the attention of the participants was attracted to the paper delivered by V.Yu. Kolosov (Ural State University of Economics, Yekaterinburg, Russia), devoted to rotational distortions during the growth of crystalline grains in a vitreous matrix; the paper delivered by A.A. Babaev (Institute of Physics, Dagestan Scientific Center, Russian Academy of Sciences, Makhachkala), which was on special features of the photoluminescence in chalcogenide vitreous semiconductors; a series of the studies carried out by the team headed by V.V. Sobolev (Izhevsk State University, Russia), which were concerned with electronic structure and calculations of the fundamental optical functions of selenides, sulfides, and chalcogenides consisting of various elements; and a series of studies on the electrical properties of chalcogenide vitreous semiconductors that were carried out at the Uzhgorod National University, Ukraine (the corresponding paper was delivered by I.V. Fekeshgazi).

Many papers dealing with the technical applications of amorphous, microcrystalline, and vitreous semiconductors were presented at the conference. I would like to mention the paper delivered by I.M. Kotina (St. Petersburg Institute of Nuclear Physics, Gatchina), which was concerned with the use of a heterocontact between amorphous silicon and crystalline silicon in nuclear-radiation detectors; the paper delivered by M.D. Efremov (Institute of Semiconductor Physics, Novosibirsk), which focused on simulation of the characteristics of thin-film field-effect transistors based on films of hydrogenated amorphous silicon; and a series of studies related to the effect of the electrical properties of *a*-Si:H films on the current–voltage characteristics of thin-film field-effect transistors (these studies were carried out by a team of researchers, headed by S.P. Vikhrov, from Ryazan State Radio-Engineering Academy). Studies on the holographic writing of information have been continued with good results by a team headed by Ya. Teteris (Institute of Physics, University of Latvia, Riga, Latvia); the corresponding paper was presented by I. Kuzmina.

The topical issues of the conference were discussed at seven poster sessions, where 158 papers were presented.

It was noted at the closing round-table discussion that the presented papers were of high scientific quality and corresponded to the current state of world science. This inference is confirmed by the participation of scientists from Russia and the Commonwealth of Independent States in international conferences possessing the same scope as this conference and, also, by the large number of studies carried out by the authors in cooperation with scientists from prominent world scientific centers. A number of studies conducted by the participants of the conference were innovative and of great importance; moreover, the results of these studies were often being reported for the first time. In particular, these studies were concerned with the development and implementation of new approaches to the writing of information on carriers made of chalcogenide vitreous semiconductors and the development of a new class of polyhomoconjugated organometallic compounds that exhibit clearly pronounced semiconductor properties and demonstrate potential (as was mentioned above) in relation to the development and fabrication of a number of microelectronic devices.

The number of scientific personnel working in the field under consideration corresponds to the current state of Russian Science; in particular, this circumstance manifests itself in the fact that a large number of the studies reported at the conference were supported by international agencies (INTAS, NATO, and CRDF). According to the data mentioned in the abstracts of the papers presented at the conference, 32 participants of the conference were supported in their studies by the Russian Foundation for Basic Research; 25, by the Ministry of Education; 4, by the Ministry of Industry and Science; 2, by the International Science & Technology Centre; 17, by grants received from various Russian programs for the support of scientists and scientific schools; and 8, by INTAS. Fifteen of the participants were involved in other foreign programs. However, it was noted by the participants of the conference that the funding of studies carried out in the majority of research institutes is inadequate, especially in the case of providing the institutes with modern equipment for technology and research.

The scientific level of all the presented papers was fairly high. The proceedings of the conference have been published. In addition, the Program Committee recommended publishing the most interesting papers in this issue of "Fizika i tekhnika poluprovodnikov" ("Semiconductors").

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