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St. Petersburg Polytechnical University Journal: Physics and Mathematics 2 (2016) 63–70

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Results of the 17th All-Russian Youth Conference on Semiconductor and Nanoctructure Physics and Semiconductor Opto- and Nanoelectronics

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Available online 15 March 2016

Abstract

The paper summarizes the results of the 17th All-Russian Youth Conference on Semiconductor and Nanostructure Physics and Semiconductor Opto- and Nanoelectronics that took place in St. Petersburg on November 23–27, 2015. The organizers and the sponsors of the conference have been listed. The reports presented in the 6 sections of the conference have been reviewed analytically. The participants whose reports were awarded certificates and money prizes by the Conference Program Committee have been mentioned. The list of reports is presented that are recommended to take part in the 'UMNIK' contest (the acronym for the youth science and innovation contest means 'a clever person' in Russian) in the nomination 'Scientific results which have significant novelty and the prospect of commercialization' and shall be further funded by the Foundation for Assistance to Small Innovative Enterprises in Science and Technology.

Keywords: Semiconductor physics; Nanoelectronics; Optoelectronics; Heterostructure; Nanostructure.

The 17th All-Russian Youth Conference on Semiconductor and Nanostructure Physics and Semiconductor Opto- and Nanoelectronics took place in St. Petersburg from November 23–27, 2015. The conference was organized by the Peter the Great St. Petersburg Polytechnic University, the St. Petersburg Academic University and Nanotechnology Research and Education Centre of the Russian Academy of Sciences, the St. Petersburg State University, and the Ioffe Institute of the Russian Academy of Sciences. The conference was financially supported by the Russian Foundation for Basic Research (grant no. 15-32-10297 mol_g) and by the ATC-Semiconductor Devices company.

The Program Committee, headed by a member of RAS Dr. R.A. Suris of the Ioffe Institute, and the Organizational Committee, headed by Dr. L.E. Vorobiev of Peter the Great St. Petersburg Polytechnic University, put much effort into organizing the conference.

Over 200 participants from 30 universities and research centers of 13 cities of Russia, including the research and educational centers of Siberia (Novosibirsk, Tomsk), the Urals (Yekaterinburg) and European Russia (Moscow, St. Petersburg, Nizhny Novgorod,

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http://dx.doi.org/10.1016/j.spjpm.2016.03.001

Volgograd, Voronezh, Kazan, Saratov, and Penza) took part in the conference. For the first time, young scientists from the Russian-Armenian Slavonic University (Yerevan, Armenia) attended the conference.

The program of the 17th All-Russian Youth Conference covered the advances in the key areas of modern semiconductor and nanostructure physics and semiconductor opto- and nanoelectronics in Russia. These are the studies of electrical, magnetic, optical, luminescent, and photoelectrical properties of bulk materials and film structures, of semiconductor surfaces and interfaces. Most of the reports were dedicated to the problems of nanoelectronics. In particular, results of experimental and theoretical studies of structures with quantum wells, quantum wires, quantum dots and nanoclusters, and studies of nanocomposites and other new materials and structures were presented at the conference. There is still a keen interest in carbon-based structures (fullerenes, carbon tubes, graphene) and in nanoporous and composite materials, particularly those with nanoscale inclusions. There has been noticeably more reports dedicated to the technologies for fabricating semiconductor structures and devices based on them.

The conference program included two guest reports, presented by two leading Russian scientists, familiarizing the young researchers with the modern state of semiconductor and nanostructure physics and semiconductor opto- and nanoelectronics. These reports were 'Two- and three-dimensional topological insulators' made by Dr. S.A. Tarasenko (Ioffe Institute), and 'Semiconductor lasers with an ultra-narrow radiation pattern' by Dr. M.V. Maximov (Ioffe Institute, St. Petersburg Academic University).

During the 9 plenary sessions of the conference, undergraduate and graduate students gave 42 spoken reports. Furthermore, 88 reports were given in a poster session held in six sections that were 'Bulk properties of semiconductors', 'Heterostructures, superlattices, quantum wells', 'Structure growth, surfaces and interfaces', 'Quantum dots, quantum wires, and other low-dimensional systems', 'Optoelectronics and nanoelectronics devices', 'Novel materials'.

Abstracts of the conference [1], as well as the conference program were published in 200 copies.

Analytical review of the reports presented

The range of problems discussed in the 'Bulk properties of semiconductors' section attests to a heightened interest in the magnetic properties of materials, both in the spin properties of charged particles, and in the magnetic properties of atoms manifesting in semiconductor compounds and solid solutions. We should mention here the experimental studies of the structure, the specifics of electron transport and the magnetic properties in doped $PrSMnO_3$:Y, $LaMnO_3$:Sr and $CeMnO_3$:Sr manganites which are materials that could be successfully used for fabricating magnetically controllable electronic devices; the study of the magnetic properties of CdHgTe:Mn and HgSe:Cr; the study of magnetic transmission and magnetic reflection in crystals of $HgCr_2Se_4$–$CdCr_2Se_4$ solid solutions with a spinel structure exhibiting a high degree of electron spin polarization and giant Faraday and Kerr effects; the theoretical studies proving the possibility of spin polarization of charged particles via the spin filtration of electrons by paramagnetic impurity centers in bulk semiconductors; the theoretical studies of the Hall effect during current carrier scattering by a magnetic skyrmion, relevant for solving problems related to an increase in information density in magnetic systems; the experimental studies of spin noise.

The following noteworthy reports were dedicated to investigating the physical properties of group III nitrides and the technologies for obtaining materials and structures based on these compounds:

- the theoretical and experimental studies of the effect of the plasmon–phonon interaction on the optical properties of the gallium nitride (GaN) in the infrared and the terahertz spectral ranges, revealing, in particular, that the reflection spectra in the plasmon–phonon modes are a sensitive tool for non-contact sample investigation;
- the study of the photoexcitation spectra and kinetics in indium nitride;
- the experimental study of screw dislocations in GaN as effective sources of ultraviolet radiation.

Interesting results have been obtained in the experimental studies on the effect of indium impurities on the electrophysical properties of $Ge_2Sb_2Te_5$ films used in non-volatile phase memory devices; in the studies of the structural properties of GaP(As)N solid solutions as a component of the InGaPAsN system (showing a good agreement of the lattice constant with silicon); in the studies dedicated to the aging of TiO_2 doped by nitrogen; in the experimental study of hydrogen passivation of deep dislocation layers in silicon, which is a procedure that significantly improves the quality of monocrystalline silicon wafers used for fabricating solar cells.

The works presented in the 'Structure growth, surface and interfaces' section cover a wide range of