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EDITORIAL

**NANOBIOPHYSICS: FUNDAMENTAL AND APPLIED ASPECTS.
NEW INFORMATION ABOUT RECENT PROBLEMS AND PROGRESS
ACHIEVED IN THIS FIELD**

(Information about 5th International conference
“Nanobiophysics: Fundamental and Applied Aspects” – NBP-2017)

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Among new branches of natural sciences, which are currently emerging, development of a novel field of nanobiophysics was impelled by the advent of nanoscience in qualitatively new direction interfacing bionanoobjects and nanomaterials. To shape this field in Ukraine, a new series of biennial international conferences “Nanobiophysics: fundamental and applied aspects” was established in 2009 by biophysicists of B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine (Kharkov) and Institute of Physics of the National Academy of Sciences of Ukraine (Kiev). After the lapse of eight years the 5th NBP-2017 conference has demonstrated significant advances in this realm of science, overviewed in the present report. About 90 scientists from 9 countries took part in the conference. They presented more than 40 lectures and about 50 poster contributions. Researchers from biophysical departments of seven academic institutes and universities of Kharkov reported remarkable achievements in studies of bionanohybrids of biopolymers and biologically active compounds with inorganic nanomaterials, conducted by varied experimental techniques and computer simulations. Biophysicists from a number of Kiev academic institutes reported experimental and theoretical characterization of biomolecular nanosystems promising for nanotechnology and biomedical applications. Impressive achievements in biophysical studies at the nano level were presented in the invited lectures of leading specialists from Estonia, France, Latvia, Slovakia, South Korea, and the People's Republic of China. The conference provided a platform for meetings of participants of international projects in the field and fruitful discussion of further international collaboration.

KEY WORDS: nanobiophysics; molecular biophysics; nanotechnology; bionanohybrids; bionanostructures.

**НАНОБІОФІЗИКА: ФУНДАМЕНТАЛЬНІ ТА ПРИКЛАДНІ АСПЕКТИ.
НОВА ІНФОРМАЦІЯ ЩОДО НАГАЛЬНИХ ПРОБЛЕМ ТА ДОСЯГНЕНЬ У ЦІЙ ЦАРИНИ
(Інформація про 5-ту міжнародну конференцію «Нанобіофізика:
фундаментальні та прикладні аспекти» НБФ-2017)**

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Біофізика як одна із сучасних природничих наук з появою нанотехнології отримала поштовх у якісно новому напрямку поєднання біонанооб'єктів та наноматеріалів, що породило нову галузь – нанобіофізику. Для формування цього напрямку в Україні у 2009 році біофізиками Фізико-технічного інституту низьких температур ім. Б.І. Веркіна НАН України (Харків) та Інституту фізики НАН України (Київ) була заснована серія міжнародних конференцій «Нанобіофізика: фундаментальні та прикладні аспекти». Через вісім років п'ята конференція НБФ-2017 продемонструвала значний прогрес у цій галузі науки, що становить предмет цього огляду. У конференції взяли участь 90 науковців з 9 країн світу і представили понад 40 доповідей та близько 50 стендових презентацій. Дослідники біофізичних відділів 7 академічних інститутів та університетів Харкова доповіли про суттєві досягнення у дослідженнях біонаногібридів біополімерів та біологічно активних сполук з неорганічними наноматеріалами, які проводилися різними експериментальними методами та комп'ютерним моделюванням. Біофізики академічних інститутів Києва повідомили про результати експериментальних та теоретичних досліджень біомолекулярних наносистем, перспективних для нанотехнології та біомедичних застосувань. Вражаючі досягнення біофізичних досліджень на нано-рівні були представлені у

запрошених лекціях провідних спеціалістів з Естонії, Франції, Латвії, Словаччини, Південної Кореї та Китайської Народної Республіки. Конференція забезпечила майданчик для зустрічей учасників міжнародних проектів та для продуктивного обговорення подальшого наукового співробітництва.

КЛЮЧОВІ СЛОВА: нанобіофізика; молекулярна біофізика; нанотехнології; біонаногібриди; біонаноструктури.

НАНОБИОФИЗИКА: ФУНДАМЕНТАЛЬНЫЕ И ПРИКЛАДНЫЕ АСПЕКТЫ. НОВАЯ ИНФОРМАЦИЯ ОБ АКТУАЛЬНЫХ ПРОБЛЕМАХ И ДОСТИЖЕНИЯХ В ЭТОЙ ОБЛАСТИ (Информация о 5-й международной конференции «Нанобиофизика: фундаментальные и прикладные аспекты» НБФ-2017)

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Современная биофизика с появлением нанотехнологий получила толчок в качественно новом направлении объединения бионанообъектов и наноматериалов, породив новое научное направление – нанобиофизику. Для оформления этого направления в Украине в 2009 году биофизики Физико-технического института низких температур им. Б.И. Веркина НАН Украины (Харьков) и Института физики НАН Украины (Киев) учредили серию международных конференций «Нанобиофизика: фундаментальные и прикладные аспекты». Спустя восемь лет пятая по счету конференция НБФ-2017 продемонстрировала значительный прогресс в этой области науки, что и составляет предмет данного обзора. В конференции приняли участие около 90 ученых из 9 стран, представивших более 40 устных и порядка 50 стендовых презентаций. Исследователи биофизических отделов 7 академических институтов и университетов города Харькова рассказали о существенных достижениях в исследованиях бионаногибридов биополимеров и биологически активных веществ с неорганическими наноматериалами, которые проводили разными экспериментальными методами и посредством компьютерного моделирования. Биофизики ряда академических институтов города Киева доложили об экспериментальных и теоретических исследованиях биомолекулярных наносистем, перспективных для нанотехнологии и биомедицинских приложений. Впечатляющие достижения биофизических исследований на нано-уровне были представлены в приглашенных лекциях ведущих специалистов из Эстонии, Франции, Латвии, Словакии, Южной Кореи и Китайской народной республики. Конференция обеспечила площадку для встреч участников международных проектов и для продуктивного обсуждения дальнейшего научного сотрудничества.

КЛЮЧЕВЫЕ СЛОВА: нанобиофизика; молекулярная биофизика; нанотехнология; бионаногібриди; біонаноструктури.

5th International conference “Nanobiophysics: Fundamental and Applied Aspects” – NBP2017 was held on 2-5 October, 2017 in Kharkov, Ukraine, at B. Verkin Institute for Low Temperature Physics and Engineering (ILTPE) of the National Academy of Sciences (NAS) of Ukraine [1, 2]. NanoBioPhysics (NBP) conference series was jointly launched in 2009 by B. Verkin Institute for Low Temperature Physics and Engineering of the NAS of Ukraine and the Institute of Physics of the NAS of Ukraine. Previous four conferences were organized on biennial basis in Kiev and Kharkov alternately.

Nanobiophysics is a new branch of science which operates at the interface of physics, biology, chemistry, material science, nanotechnology, and medicine. The basic motivation of the nanobiophysical investigations includes elucidation of fundamental mechanisms of biological processes at the molecular level and interfacing this knowledge with various medical and nanobiotechnology applications.

A previous conference held at the ILTPE in 2013 was completed by book publication in 2016 [3]. The book introduced the field of nanobiophysics through 12 reviews which were presented at the NBP2013 conference as invited lectures. These reviews were focused on some selected topics related to the physics of biomolecular nanosystems, nanobiohybrids involving DNA/RNA and single-walled carbon nanotubes. Some reviews in the book describe unique experimental physical methods which are used to study nanosized biostructures. Fundamental researches are also presented through 2 reviews with strong theoretical considerations and two chapters of the book are devoted to applied aspects of nanobiophysics.

The aim of the present conference was to discuss urgent problems in a new scientific field combining biophysics and nanotechnology as well as its progress and prospects. While many problems concerning the structure, physical properties and intermolecular interactions of biopolymers are intensively studied in the framework of traditional molecular biophysics, the XXIst century arouse new challenges of integration of useful properties of biomolecules with unique capabilities of nanomaterials for advanced practical applications. This was reflected in the titles of the topics considered at the conference sessions:

- Nanobiohybrids formed by nanocarbon materials with bioobjects;
- Biomolecules on nanoparticles and nanostructured surfaces;
- Physical aspects of biomolecular nanosystems;
- Theoretical calculations and computer modeling of nanobiosystems;
- Applied aspects of nanobiophysics.

About 90 scientists from 9 countries took part in the conference. 14 invited lectures, 28 oral presentations (Fig. 1) and about 50 posters were presented, a Book of Abstracts was published [1]. A possibility to present the result of the international, in particular European, collaboration of the conference participants as well as discussion of further international projects was of great importance (Fig. 2).

The contributions of the conference hosts reflected recent achievements of the Kharkov scientific school of molecular and nano biophysics. The lecture of the conference vice-chairman Professor **Karachevtsev V.A.** was devoted to experimental and theoretical studies of interaction of nucleic acid constituents – nitrogen bases and short oligonucleotides with novel nanoform of carbon – graphene oxide (supported by the National Academy of Sciences of Ukraine grant within the program “Fundamental Problems of the creation of new Nanomaterials and Nanotechnology”). Knowledge on the properties of DNA or RNA complexes with graphene oxide is claimed due to promising applications in genosensing and gene delivery.

The subject of nanobiohybrids formed by nanocarbon materials with biomolecules was further enlightened in the presentations of the coworkers of the Department of Molecular Biophysics of the ILTPE. Dr. **Glamazda A.Yu.** reported on spectroscopic studies of DNA-wrapped carbon nanotubes aligned in the stretched gelatine film. Contribution of **Kurnosov N.V.** was focused on interaction of thiol compounds with single-walled carbon nanotubes by means photoluminescence and Raman spectroscopy. Specific for the ILTPE direction of spectroscopic studies at low temperatures was reflected in the talk of Dr. **Ivanov A.Yu.** entitled “Biomolecules in the low temperature inert matrices and graphene oxide films: structures and vibrational spectra”. Low temperature technique of freeze-drying was applied for production of carbon nanotube-polyoxymethylene nanocomposite, while low temperature mass spectrometric method was used to characterize this composite in the work presented by Dr. **Kosevich M.V.** Computer simulation of nanomaterials was described by Dr. **Stepanian S.G.** in his talk “Structure and vibrational spectra of graphene oxide: *ab-initio* modeling”. Head of Department of Spectroscopy of Molecular Systems and Nanostructured Materials of ILTPE Dr. **Komarchuk G.V.** reported about the development of innovative point-contact nanosensors for real-time detection of *helicobacter pylori* virulent strains.

Achievements of Department of Biological Physics of O.Ya. Usikov Institute for Radiophysics and Electronics of the NAS of Ukraine (Kharkov) in the area of studies of physical aspects of biomolecular nanosystems were presented in the talk of Professor **Shestopalova A.V.** devoted to revealing of particular features of structural and physical characteristics of nucleosomal DNA, which is a nanostructure formed in the living cell as well as artificially created. **Glibitskiy D.M.** informed about observations of zigzag patterns of solutions and films of bovine albumin with FeCl_3 probed by dynamic light scattering.



Ramseyer C.



Trusova V.M.



Seong Soo Choi



Ermakov V.N.



Kamarchuk G.V.



Petrov E.G.



Stepanian S.G.



Dovbeshko G.I.



Kutsevol N.V.



Yefimova G.L.



Vashchenko O.V.



Zhang B.



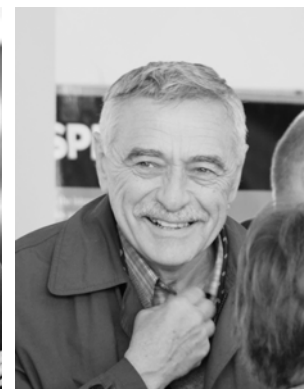
Ogurtsov A.N.



Shestopalova A.V.



Freiberg A.



Volkov S.N.

Fig. 1. Some emotional moments of the lectures at the NBP2017 conference.



Fig. 2. Informal discussions: Professor Kutsevol N.V. and Professor Víglaský V. (left), Professor Kryachko E.S. and Professor Cheranovskii V.O. at a poster session (right).

In a number of lectures basic nanophysical studies which are of interest for future pharmacological and biomedical applications were presented, in particular, in the contributions of researches of the Institute for Scintillation Materials of the NAS of Ukraine (Kharkov). Professor *Lisetsky L.N.* described results of application of differential scanning calorimetry technique to investigations of joint action of drugs in model membranes, which are useful in development and pre-clinical studies of novel drugs and drug formulations. Dr. *Vashchenko O.V.* told about distinction in individual and joint membranotropic action of calcium and magnesium stearates as medicines excipients. Dr. *Yefimova S.L.* told about physical aspect of a new approach to nanoparticle application in photodynamic therapy of cancer, namely about a novel composition on the base of porous CaCO_3 microspheres loaded with both scintillating gadolinium orthovanadate nanoparticles doped with europium ions and methylene blue photosensitizer molecules. Dr. *Seminko V.V.* reported about sensing reactive oxygen species using Ce^{3+} luminescence of cerium dioxide nanocrystals.

In the Institute for Problems of Cryobiology and Cryomedicine of the NAS of Ukraine (Kharkov) nanoscience approach presented by Professor *Osetsky A.I.* is applied to studies of bionanostructures based on cluster crystallization of the solutions with weak interaction between components.

Along with researchers from academic institutes, scientists from universities of Kharkov contribute to nanobio-investigations and education. The Department of Molecular and Medical Biophysics of V.N. Karazin Kharkiv National University was represented by Dr. *Trusova V.M.* who described physical and structural properties of amyloid fibrillar assemblies involved in pathogenesis of so-called conformational diseases, such as neurological disorders and, at the same time are promising candidates for the design of novel functional materials and devices. Professor *Ogurtsov A.N.*, Chair of Biotechnology, Biophysics and Analytical Chemistry of the National Technical University “Kharkiv Polytechnic Institute” (NTU “KPI”), discussed capabilities of nanobiophysics in bionanotechnology as a branch of nanotechnology, which uses biologically inspired structural and functional principles, methods and techniques for development of atomic-level engineering and manufacturing technologies. Dr. *Lykah V.A.* (NTU “KPI”) described theoretical modeling of charge carrier behavior in functionalized CNT with charge transfer between CNT and the attached molecules.

Advances in nanobiophysical investigations were outlined in the reports of the conference co-organizers from Kiev Institute of Physics of the NAS of Ukraine. In the framework of the “Biomolecules on nanoparticles and nanostructured surfaces” session Professor *Dovbeshko G.I.* described studies on the DNA structure and conformation in confined volume and on the nanostructured surfaces. Professor *Chegel V.I.* (V.E. Lashkaryov

Institute of Semiconductor Physics of the NAS of Ukraine, Kiev) highlighted the biomolecular aspects of molecular plasmonics. Researchers from the Bogolyubov Institute for Theoretical Physics of the NAS of Ukraine (Kiev) have presented results of theoretical considerations of various phenomena occurring in bionanoobjects. Professor **Petrov E.G.** lectured about characteristic features of kinetic processes in bionanosystems, Professor **Volkov S.N.** described physical mechanisms of regulating the DNA activity at the nanoscale, and Professor **Ermakov V.N.** told about modeling of respirator mechanism for cyanide destruction by bacteria. Professor **Kutsevol N.V.** (Taras Shevchenko National University of Kyiv) told about biomedical application of nanosystems synthesized in branched PNIPAM (poly-N-isopropylacrylamide) polymer matrices with inclusion of Au nanoparticles and a photosensitizer Clorin e6.

Presentations of international collaborators provided precious information of the main developments and trends in the nanobiophysics-related fields worldwide. Professor **Freiberg A.** (Institute of Physics, University of Tartu, Estonia) in his opening impressive lecture “*In situ* engineering of excitons in biological nanostructures” gave a comprehensive picture of experimental investigations on photosynthetic energy transfer and trapping processes mediated by excitons in special biological nanostructures - pigment-protein complexes by a photo-chemical technique and a physical method of high hydrostatic pressure.

Professor **Víglaský V.** (Pavol Jozef Šafárik University, Košice, Slovakia) reported about the revealed unusual properties of G-quadruplex motifs of DNA found in living systems and designed for nanobiotechnology. Professor **Ramseyer C.** (Université de Franche-Comté, Besançon, France) described applications of High Performance Computer science for *in silico* calculations urgent for design of drugs which are highly efficient but also very selective toward cancer cells, when *in vivo* and *in vitro* experiments cannot go further. Professor **Seong Soo Choi** (SunMoon University, Ahsan, South Korea) described current nanotechnology advancements from Coulter cell counter to single molecule plasmonic nanopore sensor. Professor **Zhang B.** (affiliated in Liaoning Shihua University, Fushun, P. R. China, and University of Freiburg, Germany) told about aromatic polyimides maximizing π -stacking interactions with carbon nanotubes by mediating their backbone conformations.

In the framework of the conference meetings of participants of international collaboration and current international projects took place. In particular, a special session dedicated to HORIZON 2020 project “Asymmetry of biological membrane: theoretical, experimental and applied aspects” (690853 — assymcurv — H2020-MSCA-RISE-2015/H2020-MSCA-RISE-2015) was organized by its European coordinator Professor **Dovbeshko G.I.** (Fig. 3). Reports on the current developments of the project were made by Professors **Ramseyer C.** (France), **Berzina B.** (Latvia), **Freiberg A.** (Estonia), **Gogotsi O.G.** (Ukraine).

Competition for the best contribution of young scientists was organized in the framework of the conference. The winners in the nomination for the best oral talks were **Miroshnychenko K.V.** with her presentation “Ligand-induced DNA conformational changes in minor groove complexes studied by molecular dynamics simulation” and **Piatnytskyi D.V.** for his “Complexes of hydrogen peroxide and DNA phosphate group in quantum chemical calculations” talk. The best poster winners were **Lapshin V.A.** for his “Nanostructured and ultradisperse materials: production by means of immersed electric discharge and application for biology and medicine” poster and **Hubenko K.O.** for her “Nanocomposite CaWO₄ in mesoporous spheres SiO₂ for X-ray induced photodynamic therapy” poster (Fig. 4).

The conference was partially sponsored by the Trade Union of the ILTPE of the NAS of Ukraine and international scientific societies – The Optical Society (OSA, http://www.osa.org/en-us/about_osa/) and The International Society for Optics and Photonics

(SPIE, <http://spie.org/about-spie>). The secretary of the Young Scientists Council of the ILTPE **Gamayunova N.V.** had informed junior participants about the opportunities provided by the Student Chapters of these societies.



Fig. 3. Participants of the HORIZON 2020 project: Dovbeshko G.I. (coordinator), Olenchuk M., Freiberg A., Rivel T., Foley S., Berzina B.



Fig. 4. Diploma for the best young scientists' contributions are awarded by Professor Karachevtsev V.A. to Hubenko K.O. and Lapshin V.A.

In this issue *Biophysical Bulletin* publishes some articles presented at the NBP2017.

The next conference of the series is expected to be organized in autumn 2019 in Kiev. More information can be found at the conference site [2].

REFERENCES

1. Nanobiophysics: Fundamental and Applied Aspects. Book of Abstracts. / Ed. V.A. Karachevtsev. Kharkiv: ILTPE NASU, 2017. 130 p.
2. 5-th International Conference NANOBIOPHYSICS: Fundamental and Applied Aspects // Conference site [Electronic resource] // Mode of access: URL: <http://www.ilt.kharkov.ua/nbp2017> – Title from the screen. – Last access: October 20, 2017.
3. Nanobiophysics: Fundamentals and Applications / Ed. V.A. Karachevtsev. Singapore: Pan Stanford Publishing, 2016. 417 p. (ISBN 978-981-4613-96-5 - Hardcover, ISBN 978-981-4613-97-2 - eBook).

REFERENCES

1. Karachevtsev, V.A. (Ed.). (2017). Nanobiophysics: Fundamental and Applied Aspects. Book of Abstracts. Kharkiv: ILTPE NASU.
2. 5-th International Conference NANOBIOPHYSICS: Fundamental and Applied Aspects. (2017). Conference site. Retrieved from <http://www.ilt.kharkov.ua/nbp2017>
3. Karachevtsev V. A. (Ed.). (2016). Nanobiophysics: Fundamentals and Applications. Singapore: Pan Stanford Publishing. <https://doi.org/10.1201/b20480>