

**Science & Technology Wing
Embassy of India
Moscow**



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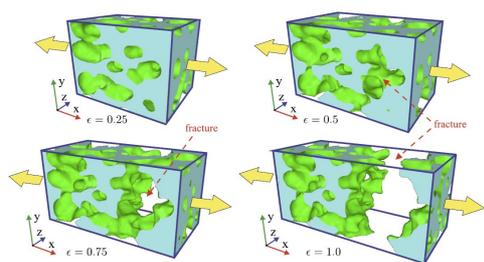
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1. Study of nitinol deformations to enrich understanding of materials with targeted properties

Source: RSF News, 18 May 2021



The work was sponsored by Russian Science Foundation; the project, headed by Professor Anatolii Mokshin, is titled "Theoretical, simulating and experimental research of physico-mechanical traits of amorphous-producing systems with heterogeneous local visco-elastic properties".

"We performed calculations for porous nitinol," shares first co-author, Associate Professor Bulat Galimzyanov. "It's widely used in various industries thanks to its unique physico-mechanical properties, such as low volume weight, high corrosion resistance, high biocompatibility and shape memory. Obtaining nitinol as amorphous foam is very labor-intensive, it requires high temperatures and extremely high melt cooling rate (over 1,000,000 K per second). Obviously, traditional experiments in this case are very costly and complex. We used computer modelling based on molecular dynamics."

As Galimzyanov explains, amorphous metallic foams are prospective materials.

"Their cell structure comprises a solid metallic frame with gas-filled pores. Pores can be either hermetic or conjoined. The volume ratio of pores and their hermeticity determine the primary physico-chemical properties of the metallic foam, among which are low heat conductivity, high plasticity, and good noise absorption. Thanks to that, metallic foams can find wide applications in the automotive industry, shipbuilding, and aerospace industry," says the interviewee.

As the research shows, amorphous porous nitinol can sustain major mechanical loads, significantly higher than crystalline nitinol.

Apart from the aforementioned applications, amorphous porous nitinol can also be used in prosthetics and biocompatible materials because it's much more resistant to stretching and shrinking than bones but has the same porousness.

2. Scientists to take a new step in microelectronics' development

Source: RSF News, 19 May 2021

Researchers at Peter the Great St. Petersburg Polytechnic University (SPbPU) developed a new approach to determine the best electrode materials composition for solid-state lithium-ion batteries. The results of the study were published in the journal *Nanomaterials*.



Scientists to take a new step in the microelectronics' development. Credit: Peter the Great St.Petersburg Polytechnic University

The development of miniature devices such as sensors and Internet of things (IoT) devices requires establishing small and complex power supplies with a high energy density. According to experts, traditional technologies for lithium-ion battery production reach their limits. It is difficult to reduce the size and control the shape of the power source any further in the required nano and micron dimensions. Meanwhile, micro and nanoelectronic technologies, such as Atomic Layer Deposition, can assist in producing miniature solid-state lithium-ion batteries with high specific energy.

Studying the new nanoscale materials for electrodes of lithium-ion batteries, the research group of St. Petersburg Polytechnic University developed a method to determine the electrochemical capacity of each component of the nickel-cobalt oxide system. Transition metal oxides have a high capacity and relatively low costs, which is required to develop lithium-ion batteries. In the investigation of thin films

obtained by atomic layer deposition (ALD) were used as anode materials and demonstrated a high charge capacity at high current densities.

"We obtained nickel-cobalt oxide materials in the wide range of compositions from nickel oxide to cobalt oxide and proposed a method to determine the contribution of the capacity of each of the electrochemically active components of the charge/discharge process. This multipurpose technique can be used to determine the best materials' compositions for lithium-ion batteries," notes Dr. Maximov of High School of Materials Physics and Technologies, Institute of Mechanical Engineering, Materials and Transport SPbPU.

In the future, the scientists plan to use their developments to create improved cathodes and solid electrolytes to produce a prototype of thin-film solid-state lithium-ion batteries.

The project was supported by Russian Science Foundation.

3. Scientists will clear urban water bodies of toxic algae using ultrasound

Source: Scientific Russia news portal, 29 June, 2021

Researchers at the St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPb FRC RAS) are developing a method for cleaning water bodies from cyanobacteria (blue-green algae). Their waste products are dangerous toxins that can threaten human health. Now scientists have begun a series of tests of ultrasonic devices and corresponding methods of combating harmful

microorganisms, experiments are taking place near St. Petersburg.



Ultrasonic device prototype

"Blooming" of cyanobacteria is an urgent problem for many water bodies near settlements in Russia and other countries of the world, it can very heavily pollute the water body, including harmful toxins that can have a serious negative effect on human health (diseases of the skin, liver and other organs), if he swims or consumes water from such an area.

"The fight against cyanobacterial" bloom "of water bodies requires the development of environmentally friendly methods that have minimal impact on the ecosystem as a whole, but give a noticeable end result in terms of suppressing the development of cyanobacteria. And here the most promising is the method based on the use of low-power ultrasound," says Vladimir Rybakin, Senior Researcher, Head of the Laboratory for Complex Problems of Limnology at the Institute of Lake Science of the Russian Academy of Sciences (a subdivision of the Federal Research Center of the Russian Academy of Sciences).

Why do ponds bloom?

Cyanobacteria exist in almost all rivers and lakes. However, their number is usually small, and therefore imperceptible for residents of settlements near water bodies. However, in the process of economic activity of people in cities, villages, gardening, as well as at agricultural enterprises, products rich in phosphorus and nitrogen get into rivers and lakes in large quantities.

For cyanobacteria, such substances are food, so their amount in the reservoir increases rapidly, and the "bloom" of water is the result of their metabolism. "It's not very pleasant to swim in such a reservoir. In addition, if the algae population is toxic - this must be checked separately - then it can also be dangerous. Especially if in such reservoirs people take water for drinking and household needs," says Vladimir Rybakin.

The consequences of using the water of flowering reservoirs for drinking purposes are, in particular, the "Gaff" and "Yuksov" diseases with their characteristic mortality of livestock and other animals, poisoning of people, often with fatal outcomes for them. For these reasons, cyanobacteria bloom in reservoirs is receiving increased attention. To date, many different approaches have been proposed, however, a universal method for regulating the "bloom" of cyanobacteria in water bodies has not yet been developed.

Control methods

It is quite difficult to contain the spread of cyanobacteria, especially if the reservoir is

heavily polluted by their waste products. Even with the liquidation of economic activities near the water area, a long period will be required to restore the reservoir. In addition, the use of chemicals that are guaranteed to kill algae is dangerous for humans and the inhabitants of the water area.

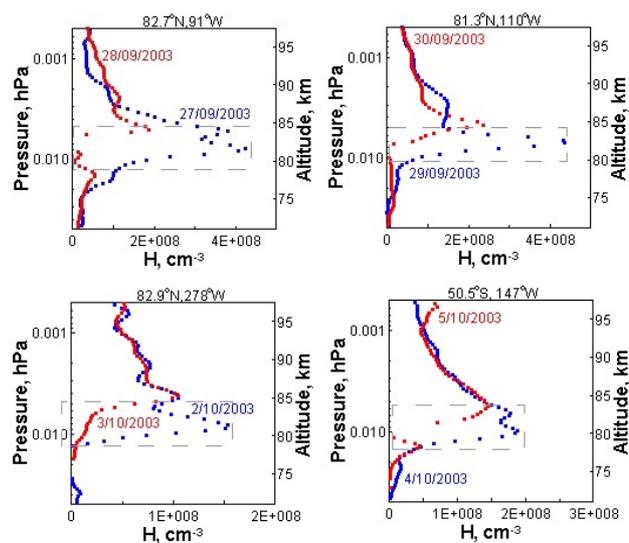
Therefore, now scientists of the Institute of Lakes Science of the Russian Academy of Sciences have begun testing an alternative, environmentally friendly and safe method for other living organisms - suppressing the mass development of blue-green algae by ultrasonic exposure.

“We have already developed prototypes of installations with a source of ultrasound of a special quality, which reduce the rate of development of blue-green bacteria, while not interfering with the life of other types of algae useful for the reservoir,” says Vladimir Rybakin.

However, in order for ultrasonic devices to effectively fight cyanobacteria, it is necessary to develop methods for additional, complex treatment of water bodies. For example, experiments are now underway in water areas of a small area, but since ultrasound quickly decays in water, work is underway to increase its range. The researchers are conducting a series of experiments on the effects of ultrasound on cyanobacterial communities in the ponds of St. Petersburg, this work will be completed in the fall. The ultimate goal of scientists is to bring to the market an installation for cleaning water bodies from algae and the method of its application.

4. The first experimental confirmation of 2-day photochemical oscillations in the Earth's atmosphere

Source: Scientific Russia news portal, June 30, 2021



An example of processing SABER / TIMED measurement data for 2003. Vertical profiles of atomic hydrogen concentration in 4 different geographic regions at the end of two consecutive nights characterized by high (blue dots) and low (red dots) atomic hydrogen concentration are given.

Photochemical processes have a key effect on the most important characteristics and components of the earth's atmosphere: its energy balance, the state and evolution of the ozone layer, the aerosol-chemical composition of the air that people breathe. One of the most important factors determining the course of photochemical processes is the daily variations in solar illumination caused by the rotation of the Earth around its own axis. These variations lead to a well-known effect - fluctuations in the

concentrations of chemical constituents of the atmosphere with a period of 1 day, recorded at different heights. In addition, researchers from the Institute of Atmospheric Physics of the University of Rostock (Germany) and the Institute of Applied Physics of the Russian Academy of Sciences (Nizhny Novgorod) predicted that at altitudes of 80-90 km (the so-called mesopause region, where the air temperature drops to the lowest values in the atmosphere, reaching -170 degrees Celsius), special photochemical oscillations with a period of two days can occur, which are a consequence of a nonlinear photochemical response to daily variations in illumination. Interest in this phenomenon is dictated by the possibility of its manifestation in the evolution of other characteristics of the atmosphere, as well as from the point of view of predicting its occurrence at other altitudes, including as a result of an artificial periodic effect on the atmosphere.

In previous theoretical studies, it was also shown that the registration of 2-day oscillations provides new opportunities for assessing a number of the most important, but inaccessible to direct measurements of atmospheric parameters. Nevertheless, the question of the detection and instrumental study of such oscillations remained open up to the present time. The main difficulty in registering this phenomenon is associated with its localization in a narrow range of heights (2-4 km), as well as with great difficulties in monitoring chemical processes at the heights of the mesopause.

In a recent paper by authors from the Institute of Applied Physics, Russian Academy of Sciences, published in the American Geophysical Union Geophysical Research Letters, indicators of the presence of this phenomenon in the measurement data were identified, and the first successful attempt was made to detect these indicators in the results of satellite sounding of the mesopause region. It was demonstrated that the main feature of nonlinear photochemical oscillations with a period of 2 days is a significant - by several orders of magnitude - difference in the concentrations of atomic hydrogen at the end of successive nights. A prerequisite for the occurrence of two-day oscillations is a strong (by more than an order of magnitude) deceleration of the evolution of the concentration of atomic hydrogen at the end of nights with its high concentration. Using the found indicators for processing the data of the SABER experiment (Sounding of the Atmosphere using Broadband Emission Radiometry) obtained with the instrument, installed on the TIMED satellite (Thermosphere Ionosphere Mesosphere Energetics and Dynamics), made it possible to identify about 200 episodes within 1 year of measurements that meet the found criteria. Thus, the first experimental evidence for the excitation of nonlinear photochemical oscillations in the Earth's atmosphere has been obtained.

5. Ancient Human Bones Reveal Oldest Known Plague Strain

Source: *Scientific Russia news portal*, June 30, 2021



DNA analysis shows that this strain appeared 7100 years ago and was less dangerous than the Black Death strain .

The DNA of the jawbone of a 20-30-year-old hunter-gatherer who lived thousands of years ago in the territory of modern Latvia, revealed a recently identified strain of the plague bacterium *Yersinia pestis*, which appeared about 7100 years ago - the oldest that has ever existed.

The oldest known strain of the plague bacterium, *Yersinia pestis*, was found in the bones and teeth of a man buried thousands of years ago in today's Latvia.

Genetic analysis suggests that the *Y. pestis* strain that infected humans originated about 7,100 years ago, researchers report online June 29 in *Cell Reports*. He is older than the previous

record holder, found in a Scandinavian mass grave 5,000 years old, associated with a possible plague epidemic. The bones of the Latvian male are also around 5,000 years old, but DNA comparisons show that he contracted a less virulent strain that appeared 1,000 years earlier in *Y. pestis* history than the one found in the Scandinavian site.

Bacterial DNA also indicates that the victim of the ancient plague did not develop pustules and did not become infected with his family. And this strain did not have the gene for the rapid transmission from fleas to humans, which originated about 3,800 years ago and caused later epidemics of bubonic plague, says Ben Krause-Kiora, an archaeologist and biochemist at Keele University in Germany.

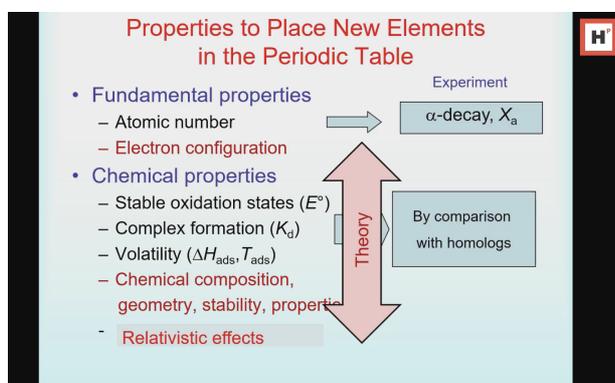
Krause-Kiora and his colleagues concluded that this early plague strain was most likely transmitted to humans through isolated encounters, such as from rodent bites. The man was carefully buried and the team found no mass graves or *Y. pestis* infection in other people's DNA, suggesting that people in the area were not experiencing an epidemic. Without antibiotics, the man likely died from the infection.

Although this *Y. pestis* strain is the oldest strain ever discovered, it eventually went extinct, being replaced by other, more virulent versions - a common fate in the evolutionary history of both bacteria and viruses. Later strains of *Y. pestis* may have been more infectious, but occasional encounters like this could help scientists understand the early history of the plague. "Maybe at first these are really isolated events, then they became more and more serious

before they became really dramatic in the Middle Ages,” says Krause-Kiora.

6. Valeria Pershina: Chemical behavior of superheavy elements in gas-phase experiments

Source: *Scientific Russia news portal*, 30 June 2021



From the presentation by Valeria Pershina

Today, June 30, 2021, the International Meeting on Superheavy Elements is being held at the Joint Institute for Nuclear Research. **Valeria Pershina**, Doctor of Chemistry of the State Research Institute (Darmstadt) made a presentation on the topic: "Chemical behavior of superheavy elements in gas-phase experiments: calculation and prediction." According to Valeria Pershina, before installing superheavy elements in the periodic table, it is necessary to determine their atomic number. This is knowledge of electronic configuration. "With very strong relativistic effects, atomic levels and configurations change. Superheavy elements can have

completely different electronic configurations like lighter elements. In this regard, theory is very important. It predicts electronic configurations," said the doctor of chemical sciences.

According to Valeria Pershina, in order to know the electronic configuration and prove that an element is in a certain group of the chemical table, it is necessary to study its chemical properties. In this sense, theory can design experiments. "Since the atom lives for a fraction of a second, and we practically cannot measure anything. The only thing that can be done, when an atom repeats the same cycles several times and reproduces macrobehavior, then we can show whether it behaves like a homologue or not. It is necessary to process samples, but it is practically impossible to do this in short-lived elements," the scientist noted.

Valeria Pershina told what gas chromatography is used for: "Now gas chromatography is the only tool for all experiments. The element is fed into the chromatographic column, sits there, and only with the behavior of the homologue it is possible to prove how it behaves. Only by comparing the relativistic prediction with the non-relativistic one can we prove the role of relativism in this behavior."

7. The search for new elements continues at the Factory of Superheavy Elements in Dubna

Source: *Scientific Russia news portal*, June 30, 2021



On June 30, 2021 the International Meeting on Superheavy Elements is being held at the Joint Institute for Nuclear Research in Dubna. Scientific Secretary of the FLNR JINR Alexander Karpov spoke about the preparation for the experiments and the first results. In January 2021, JINR employees successfully carried out experiments on the synthesis of the 115th element of Moscovite. It was first received in 2003. Experiments are now being carried out to obtain beams of accelerated particles, which are needed for the synthesis of heavier elements - 119 and 120.

Today, the probability of obtaining a superheavy element consists of the probability of nuclear fusion and the probability of the resulting nucleus surviving during cooling. The latter process is essential in experiments. It resembles the evaporation of a liquid. Molecules

evaporate only in liquid, and neutrons in nuclei. Neutrons carry away energy from the nucleus, and the system cools down. This is one of the circumstances that limit the production of superheavy nuclei.

Recently, JINR employees completed a series of experiments with the reaction of plutonium-242 and calcium-48 to obtain element 115 and proceeded to work on the synthesis of elements 119 and 120. For the synthesis of element 119, it is planned to use the titanium-berkelium reaction, and for the synthesis of element 120, the titanium-californium and chromium-curium reactions.

8. Scientists have investigated the fundamental properties of nanocrystals of halide perovskites

Source: *Skoltech*

Scientists from Skoltech and the Ludwig-Maximilian University of Munich (LMU) in Germany investigated the fundamental properties of halide perovskite nanocrystals, which are promising for use as a new class of materials for optoelectronics. Having completed a complex of theoretical and experimental studies, scientists have shown and substantiated the presence of complex relationships between the composition of the material, the dynamics of changes in its crystal lattice under the influence of light and the stability of the material. The research results are published in the journal *Nature Communications*.



Perovskite nanocrystals (PNC) are semiconductor nanocrystals, which, due to their unique properties, are used in optoelectronics and, in particular, in lasers and light-emitting diodes. The photoluminescence quantum yield of PNCs is much higher than that of bulk materials. In addition, quantum-size effects appear at the nanoscale, which can be used as an additional means of adjusting the optical properties of a material. Metal halide perovskites possess special electronic properties, due to which the optical properties of nanocrystals made of these materials become more resistant to defects in comparison with other semiconductor materials.

Senior Lecturer at the Skoltech Center for Energy Technologies (CEST) Sergei Levchenko and his colleagues performed atomistic simulations that explained the results obtained using femtosecond pump-sensing spectroscopy, which allows observing lattice dynamics in real time. Scientists have investigated the dynamics of coherent lattice vibrations for hybrid halide PNCs, i.e. changes in the atomic structure of PNC upon excitation by a laser pulse with a

duration shorter than the period of vibrational modes.

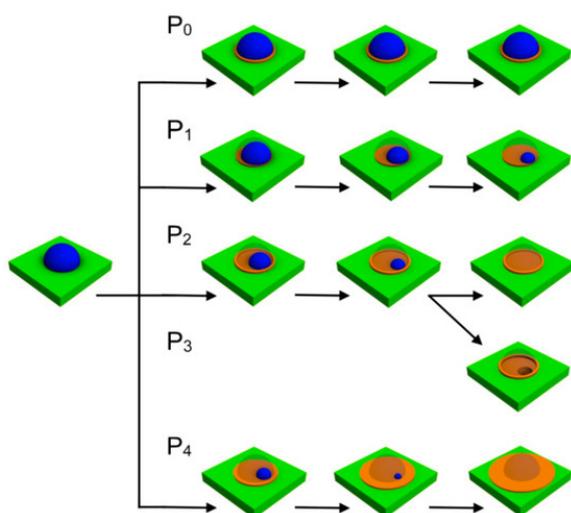
In particular, the researchers found that the transfer of energy between vibrational modes in iodine-based perovskite nanocrystals is much more pronounced than in bromine-based nanocrystals. This is due to the difference in the interaction between the inorganic base and the organic portion of the organo-inorganic halide PNCs.

“The results we have obtained open up possibilities for rational control of the fundamental properties of PNC, including the transfer of energy during optical excitation and relaxation of charge carriers, by changing the composition of the material,” says Sergei Levchenko.

9. Arsenic Streams Helped Shrink Nanostructures for Quantum Devices

Source: Russian Science Foundation

Russian physicists have developed a new way to control the size of quantum dots - semiconductors so small that they exhibit quantum effects. Scientists have found that they can be created by applying small drops of substances to a substrate and reducing them using arsenic flows. This allows researchers to control the size and density of the resulting nanostructures, which is useful in the development of microlasers and nanotransistors. The article was published in the journal *Nanomaterials* with the support of a grant from the Presidential Program of the Russian Science Foundation (RSF).



Reduction of droplets at different pressures of arsenic flow Source: Balakirev et al./ Nanomaterials, 2021

The search for innovative methods of creating new materials is necessary to improve the strategic positions of the Russian Federation in the development of an electronic component base. One of the key directions of the scientific and technical development of the electronic industry in the Russian Federation is the technology of creation and production of digital electronics, opto- and photoelectronic component base, microwave electronics based on GaAs (gallium arsenide) for all areas of application.

Quantum physics is one of the most promising scientific fields. A special place in it is occupied by the study of quantum dots - very small semiconductor particles that behave like atoms (have a discrete, that is, "discontinuous" radiation spectrum). The glow color (and absorption) of quantum dots is highly dependent

on a variety of factors. Among them, not only the material from which they are made, but also the size and shape of the particles. The features of these structures are already being actively used, creating displays with improved color reproduction. They are also used in hybrid solar cells, where quantum dots help convert the sun's energy into electricity.

Epitaxy, that is, the growth of one crystalline material on top of another, has become the main method for producing quantum dots. However, the commonly used approaches are severely limited in controlling the size and shape of such particles. This becomes a problem when you need to place quantum dots far from each other. Another method, droplet epitaxy, gives a little used to greater freedom. This approach assumes that first droplets of metal (for example, indium or gallium) are applied to the substrate, and then they are kept in a stream of arsenic, which reacts with the metal, forming a new chemical compound. As a result, the droplets turn into tiny semiconductor particles.

Using this technology, you can usually make either very small dots with a high density, or large ones with a low density, but it is very difficult to get small and rare dots at the same time. A team of young scientists from the Southern Federal University (Taganrog) found a way to get around this limitation. Technologists proposed to first precipitate large and rare metal droplets, and then to reduce the size by acting on a very small (100 times less than usual) flow of arsenic. In this case, the number of arsenic molecules is not enough to immediately convert the entire metal into a semiconductor, but it is enough for the metal atoms to scatter from the drop "in search of" arsenic on the substrate

surface, thereby reducing the droplet size to the required values. At the same time, the density of the drops does not change - they remain as rare as they were initially.

“ Our approach is universal. We hope that in a similar way it will be possible to control the size of nanostructures not only based on arsenic compounds, but also antimony and phosphorus. If the optical properties of the obtained structures meet certain criteria, then it will be possible to talk about progress not only in the technology of obtaining semiconductor nanostructures, but also in the technology of creating devices for quantum electronics and nanophotonics , ”comments Maksim Solodovnik , Candidate of Technical Sciences, Associate Professor of the Institute of Nanotechnology, Electronics and instrumentation of the Southern Federal University.

10. Scientists have developed a safe technology for recycling gunpowder waste

Source: Novosibirsk State Technical University

Scientists of the Novosibirsk State Technical University NETI have patented a technology for recycling gunpowder waste and pyrotechnic compositions (PTS) using alkalis, phosphoric acid and ash and slag waste. The technology allows you to reduce the hazard class of waste and not resort to an environmentally friendly and unsafe method of disposal by incineration.



Today, Russian enterprises working with gunpowder and pyrotechnic compositions have a problem with the disposal of such waste. Defense enterprises and enterprises producing fireworks are forced to dispose of this explosive and flammable waste in the most primitive way: they are simply burned in a specially fenced area. However, very often such a disposal site is located within the city limits. Local residents complain about noise and aerosol odors. In addition, this method of disposal is not possible in bad weather.

The development of Novosibirsk scientists makes it possible to turn waste pyrotechnics and powder-containing substances into less hazardous ones, regardless of the location of the enterprise and under any weather conditions.

“At our department, methods of waste disposal are being actively developed. We have proposed a fairly simple technology for the disposal of wastes of gunpowder and pyrotechnic compositions (PTS) - treatment with concentrated alkali at a high temperature. As a result, an alkaline mixture is formed, which is neutralized with a fairly harmless phosphoric acid. Then the resulting viscous product is

hardened using ash and slag waste. A patent has been received for this invention, and now it has been implemented at the Novosibirsk Cartridge Plant, "said Viktor Aleksandrov, Associate Professor of the Department of Environmental Engineering Problems of NSTU NETI.

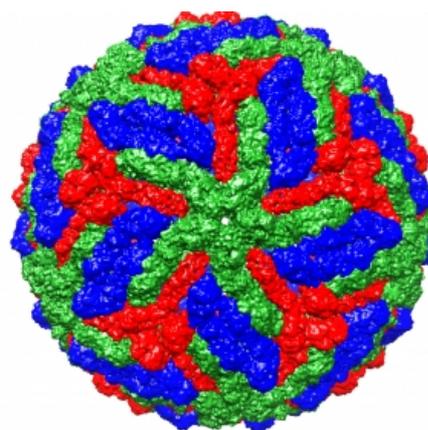
According to Aleksandrov, what remains of the PTS after the application of the development of Novosibirsk scientists is also waste, but already without flammable and explosive properties. Such wastes are classified according to the fourth hazard class (low-hazard substances suitable for disposal at MSW landfills).

"All stages of laboratory research have been completed at NSTU NETI; a pilot plant for 1 kg of one-time loading has been created. The installation passed the factory tests, and then we, together with the staff of the cartridge plant, finalized the proposed technology up to the installation of a five-kilogram capacity," Aleksandrov said.

In addition to the Novosibirsk Cartridge Plant, several other Siberian enterprises have shown interest in the development. It is important that alkalis, phosphoric acid and ash and slag waste are not expensive materials, that is, the development of PFS utilization is cost-effective. Currently, the technology is designed to dispose of about a hundred kilograms of waste per year. However, as noted by scientists, there are enterprises in the country that produce more PTS waste. Without changing the essence of the technology, the developers are ready to adapt it for large volumes of processing and disposal.

11. Scientists have established the structure of a mature yellow fever virus

Source: National Research Center "Kurchatov Institute"



Scientists of the National Research Center "Kurchatov Institute" have found out the device of a mature viral particle of yellow fever. It is this form that is the most infectious. In the course of the study, specialists first studied the structure of the surface protein, which is responsible for the penetration of the virus into the cells of the body - that is, it plays a key role in the infection process. The data obtained will help develop drugs for the treatment of yellow fever, which have not yet been developed.

Yellow fever is a disease that occurs mainly in tropical regions of Africa and America and is transmitted through the bite of a mosquito. Death occurs in 5–20% of cases at normal times and reaches 50–60% during epidemics. There is currently no specific treatment for yellow fever. The only way to combat it is vaccination, but

the hard-to-reach and disadvantaged areas of the tropics are not covered by vaccination.

Until now, knowledge about the structure of the yellow fever virus was limited only to data on the structure of its immature form, while not differing in high resolution.

Valeria Samygina, Head of the Department of Structural Biology at the Kurchatov Institute, stressed the uniqueness of the new study: “ The fact is that the yellow fever virus is characterized by a set of forms corresponding to different stages of particle ripening. For the first time, we managed to establish the structure of a mature viral particle - the one that poses the greatest danger to humans. ”

Experts have found that the yellow fever virus has a structural similarity to the viruses of Japanese encephalitis, Zika and Dengue, but it is characterized by some differences in the structure of the protein coat. According to scientists, knowledge of these features will help to select effective means capable of purposefully blocking the activity of this particular virus.

The study was carried out using a Titan Krios cryogenic transmission electron microscope, which operates at the Kurchatov Institute. Scientists note that this device, unique for Russia, equipped with a modern highly sensitive detector, makes it possible to study biological macromolecules with an extremely high resolution. “In the process of research, we used tens of thousands of images of viral particles fixed in the thinnest film of amorphous ice in order to determine the three-dimensional structure from their projections ,” said Evgeny Pichkur, an employee of the Department of Structural Biology at the Kurchatov Institute.

The study also involved specialists from the FNTSIRIP named after M.P. Chumakov RAS. This work was supported by the Russian Foundation for Basic Research.

12. The project of a postgraduate student of ETU "LETI" will allow working with drones online

Source: SPbGETU "LETI" news, 25 May, 2021

Today robotic systems are incredibly in demand in all spheres of human life. They are capable not only of detecting and preventing fire hazardous situations, creating millions of parts for machines and equipment, but also delivering a person from one point to another. The launch of unmanned solutions not in the simulator space, but in the real world, is accompanied by big problems of controlling these vehicles and assessing the quality of management. Therefore, it is very important to timely and promptly maintain these systems, but operators do not always have access to the equipment.

“Access to equipment could always be an obstacle to the development of science, especially in the context of a pandemic,” notes Konstantin Chaika.

To facilitate the process of debugging robotic equipment, to make it possible to carry out it remotely and to expand the possibilities when working with unmanned vehicles, the project of a postgraduate student of the Department of Mathematical Support and Computer Applications (MOEVM) Konstantin Chaika

"Development of a hardware platform for remote debugging of vehicle algorithms" is intended.

"The idea of the project is to develop a service that allows you to remotely launch and debug various control algorithms for unmanned robots. In other words, anyone who has only a computer and the Internet will be able, through this service, to get remote access to a real robot, run his program on it and get a detailed result of the work, including watching it online by broadcast," says the graduate student Department MOEVM SPbGETU "LETI" Konstantin Chaika.

The hardware platform offered to young scientists allows remote development and testing of approaches and solutions in the field of autonomous vehicles in a special laboratory. Despite the reduced size, the environment of a smart city is simulated sufficiently for conducting research, and monitoring systems make it possible to quantitatively assess the quality of the solutions under study. Such a laboratory is especially relevant against the background of the Sim-to-Real approach, which is one of the key directions in the management of unmanned vehicles based on artificial intelligence technologies. This approach consists in developing a solution in a simulator that can be transferred to the real world with complete preservation of behavior and performance.

"The invention can be considered not only as a final solution, but also as a parameterized hardware-software model that allows remote debugging of the developed algorithms. It can be adapted to a different environment or type of

robots, thus making it possible to solve the problems of not only unmanned vehicles surrounded by an intelligent city, but also navigation in an industrial environment. This will allow solving problems from the field of Industry 4.0, starting with logistics tasks and ending with the tasks of controlling manipulators or other industrial robots," said Konstantin Chaika.

The graduate student is confident that this project will greatly expand the capabilities of developers of programs for autonomous robots. In order to take a step from launching your developments in the simulator to launching them on a real device, you will only need access to the Internet. The inability to build a laboratory or gain access to an existing one will no longer be an obstacle to the development of science. "In addition, this is an excellent platform for distance competitions, allowing anyone to launch their solution, get a detailed result and compare it with other participants solving similar problems," comments Konstantin.

The main analogue of the project is the AIDO Olympiad solution validation system based on the Duckietown project. However, the launch of solutions of this system is limited and does not allow access to the robot for a long time, but only launch the solution within one of the qualifications of the Olympiad.

"I love doing science because this is a great opportunity to create a sought-after solution, to make the world a little better. I would also like to thank the staff of the MOEVM department, especially the head of Kirill Vladimirovich Krinkin, for the opportunity to study the area of

interest to me. Support and the opportunity to develop in the area that interests you are very important things for a young scientist," says Konstantin Chaika.

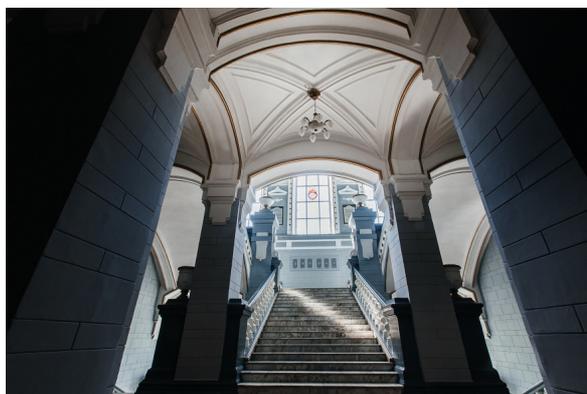
The project will be implemented in two stages. As a first step, the developer plans to create a mock-up of the system based on the laboratory of intelligent transport systems of the Institute of Artificial Intelligence, Cybersecurity and Communications. A.S. Popov, which will contain the layout of roads, monitoring systems and other peripheral equipment, as well as design the physical structure of the city - a list of hardware devices, communication lines, power and monitoring systems. The final stage will be devoted to the development and debugging of a prototype software for monitoring and resource management.

13. Material for accelerators and fire detectors for closed rooms will be developed by TPU scientists with the support of the Russian Science Foundation

Source: Tomsk Polytechnic University news

Three research groups of Tomsk Polytechnic University have won grants from the Russian Science Foundation (RSF). With the support of the fund, the teams will develop a new method of obtaining coatings for resonators of charged particle accelerators, study combustion processes in confined spaces and answer the question: how were the deposits of marine iron

ore formed on the planet. Each grant is designed for three years with the possibility of extension, the total amount of support for three projects will be 54 million rubles.



Thus, a team led by Aleksey Shevelev, a researcher at the TPU Research School of Physics of High-Energy Processes, will develop a technology for applying superconducting coatings based on triniobium stannide (Nb_3Sn) for high-frequency resonators of charged particle accelerators, as well as mathematical models and software code for studying the properties of superconductors. As a result, the scientists plan to process the prototypes of the resonator for the future generation of domestic and foreign accelerators and test them on measuring stands under superconducting conditions.

“Resonators are one of the key elements of accelerators. Today they are mostly made from expensive niobium, so researchers are looking for new materials for resonators. We suggest applying a thin coating of triniobium stannide on a more budget-friendly substrate such as copper. This is a promising material, but it has a drawback - it is brittle, while it is known that

defects in the coating can lead to the loss of superconducting properties in high-frequency fields. To solve this problem, we will try several new approaches. Obtaining high-quality, homogeneous Nb₃Sn coatings for resonators will reduce the cost of their manufacture and, in theory, increase the efficiency of particle acceleration, says **Alexey Shevelev**. The project is aimed at developing the existing cooperation of our school specialists with the largest Russian and international accelerating centers.

This is the NICA complex in Dubna, the G.I. Budker in Novosibirsk, DESY in Germany, KEK in Japan, CERN and others. "

A scientific group headed by **Aleksey Mazurov**, Professor of the Department of Geology of TPU, with the support of the Foundation, will conduct a large-scale fundamental study of ancient sedimentary deposits of iron ore. They are interesting to scientists because they are concentrated on the planet in certain areas and, according to geological standards, were formed very intensively. For example, large deposits of marine iron ore are located in Western Siberia and Northern Kazakhstan. However, geologists still do not have an unambiguous answer to the question: what exactly became the source of iron for these deposits. The answer to it will help scientists better understand the origin of not only iron deposits, but also genetically related mineral deposits and even global processes of tectonics and climate change on the planet.

The team led by Professor of the Scientific and Educational Center I.N. Butakova TPU **Genia Kuznetsov** received support from the project "Substantiation based on the results of experimental and theoretical studies of the

possibility of creating technologies with feedback for suppressing combustion and smoke deposition in closed and isolated rooms". Scientists will develop experimental techniques to determine effective conditions for extinguishing fires in enclosed spaces. To do this, they plan to use high-speed recording systems, laser technology, tracking complexes and sensors. The findings will help create a database of combustion sources and scenarios for the spread of fires in premises, as well as new types of sensors for detecting fires and lay the scientific foundations for smart fire extinguishing technologies.

We add that the Russian Science Foundation also held a competition to extend funding for previously supported projects. In it, the victory for two projects of the teams of the Tomsk Polytechnic University. This is a scientific group led by **Dmitry Glushkov**, Associate Professor of the TPU High-Energy Processes Physics Research School, which creates gel-like fuel for use in extreme temperature conditions, as well as a group of **Sergey Arbuzov**, Professor of the TPU Geology Department. His team studies valuable and toxic impurities in the coals of the basins of the Asian part of Russia.

14. Material from Russia will triple the capacity of lithium-ion batteries

Source: National University of Science and Technology MISIS

The scientists of the National University of Science and Technology "MISIS" (NUST MISIS) being a part of an international team of researches managed to increase the capacity and extend the service life of lithium-ion batteries. According to the researchers, they have

synthesized a new nanomaterial that can replace low-efficiency graphite used in lithium-ion batteries today. The results of the research are published in the *Journal of Alloys and Compounds*.

Lithium-ion batteries are widely used for household appliances from smartphones to electric vehicles. The charge-discharge cycle in such battery is provided by the movement of lithium ions between two electrodes -- from a negatively charged anode to a positively charged cathode.

The scope of application of lithium-ion batteries is constantly expanding, but at the same time, according to the scientists, their capacity is still limited by the properties of graphite -- the main anode material. Scientists from NUST MISIS managed to obtain a new material for anodes that can provide a significant increase in capacity and extend battery service life.

"Porous nanostructured microspheres with the composition $\text{Cu}_{0.4}\text{Zn}_{0.6}\text{Fe}_2\text{O}_4$, that we have extracted, used as anode material provide three times higher capacity than the batteries existing on market. Besides, it allows to increase the number of charge-discharge cycles by 5 times compared to other promising alternatives to graphite. This improvement is achieved due to a synergistic effect with a combination of a special nanostructure and the composition of used elements", -- Evgeny Kolesnikov, an assistant at the Department of Functional Nanosystems and High-Temperature Materials, NUST MISIS said.

The synthesis of the final material happens via one step process without intermediate stages due to the use of the spray-pyrolysis method. As the scientists explained, aqueous solution with ions of special metals is converted into fog with the help of ultrasound, and then water is evaporated at temperatures up to 1200°C with decomposition of the original metal salts. As the result, micron or submicron spheres with the

porosity, that is required to operate in a lithium-ion system, are extracted.

15. Russia tests COVID-19 vaccine as nasal spray for children - agencies

Source: Reuter, 12 June 2021

Alexander Gintsburg, director of the Gamaleya National Research Center for Epidemiology and Microbiology, shows bottles with Sputnik-V vaccine against the coronavirus disease (COVID-19) during an interview with Reuters in Moscow, Russia September 24, 2020.

MOSCOW, June 12 (Reuters) - Russia has tested a nasal spray form of its COVID-19 vaccine that is suitable for children aged 8-12, and plans to launch the new product in September, the scientist who led the development of the Sputnik V vaccine said on Saturday.

Alexander Gintsburg, who heads the Gamaleya Institute that developed Sputnik V, said the spray for children used the same vaccine "only instead of a needle, a nozzle is put on", the TASS news agency reported.

The children's shot is expected to be ready for distribution by Sept. 15, Gintsburg was quoted as saying during a meeting with President Vladimir Putin.

The research group tested the vaccine on children aged between eight and 12 and found no side effects among the test group, including no increase in body temperature, Gintsburg said in comments reported by the TASS news agency.

"We are inoculating our little (patients) nasally, we are just administering the same vaccine as a nasal spray," Gintsburg said, without giving

further details about the study such as how many children were involved.

16. Microtomograph for the latest space materials will be created at TPU

Source: TPU News, 18 May, 2021



Specialists of the Engineering School of Nondestructive Testing and Safety of the Tomsk Polytechnic University will develop an X-ray microtomograph to check the quality and study the internal structure of the latest domestic materials for use in space. The customer of the works is the leading materials science center of Roscosmos - JSC Kompozit.

“The materials that are being developed by JSC“ Composite ”often have no analogues. The customer has a need to conduct high-precision studies of the structure of promising materials on his site, so that, for example, it is possible to compare their parameters: what were laid down in the development and modeling, and what happened during the production of the product. For this, methods and installations of non-destructive testing are used. However, the existing solutions on the market are largely

unsuitable for the customer's products, which combine dimensions, complex shapes and composite materials. To create a new X-ray microtomography system, the customer turned to Tomsk Polytechnic University, ”says Dmitry Sednev, director of the TPU School of Non-Destructive Testing and Safety .

For JSC "Kompozit" TPU specialists will develop a complex of X-ray microtomography with a resolution of up to 50 microns (for comparison, 100 microns is the thickness of a human hair, ed.) .

“This X-ray machine will allow you to study extended objects as a whole - up to 600 mm, receive their tomographic images and determine how this or that material corresponds to the modeled parameters. The complex will consist of an X-ray tube of our design as a radiation source and a digital flat-panel detector. We will also use original software solutions that allow us to obtain a high-precision three-dimensional picture of the structure of objects. A prototype of the complex will be manufactured in the fall of 2021, and the system will be delivered to the customer in the summer of 2022, ”says Dmitry Sednev .

As part of the project, Tomsk specialists will develop a domestic microfocus X-ray apparatus with a sensitivity of up to 50 microns for use in industrial tomography. It will be several times cheaper than its foreign counterparts.

“In Russia, there are still no microfocus tubes with parameters suitable for creating microtomographic systems, and its development is a very ambitious task. Now we will make a pilot product and work out the production

technology, but we are confident that such systems will be competitive and in demand in the market," notes Dmitry Sednev .

17. Moscow State University proposed new methods of treating patients with severe COVID-19

Source: Moscow State University



Employees of the Moscow State University Medical Research and Education Center (ISEC) as part of the Moscow State University scientific school "Photonic and Quantum Technologies. Digital Medicine "presented a protocol for a new method of treating patients with a complicated coronavirus infection. The results of the work are published in the review *Cardiology* today.

It is known that with COVID-19, one of the severe symptoms is a dysfunction of the blood coagulation system, leading to blood clots in patients. Therefore, to prevent heart attacks, strokes and embolic complications, patients are prescribed anticoagulants.

Doctors at Moscow State University proposed using spironolactone for the treatment of coronavirus pneumonia and showed its effectiveness in combination with dipyridamole. Spironolactone is most commonly used to treat heart failure, fluid retention and edema and has not been previously used to treat coronavirus infection. The aim of the planned clinical trials is to investigate the possibilities of such a combination of drugs in terms of reducing blood clotting and preventing blood clots in patients. It is expected that this will increase the antifibrotic and antithrombotic effects.

"We are starting a clinical trial of a combination of spironolactone and dipyridamole for patients with a complex form of coronavirus infection. At the same time, we expect a decrease in the severity of pulmonary fibrosis and pneumonia in patients",- says an employee of the Moscow State University NOSH" Photonic and Quantum Technologies. Digital Medicine ", Deputy Director of the Moscow State University ISTC Professor Simon Matskeplishvili.

Both drugs have an excellent safety profile and, if proven to be effective, could make important contributions to the treatment of COVID-19 in a variety of clinical settings, including massive regional outbreaks during the second and third waves of infection.

18. Scientists Propose Recycling Laminated Plastics Into Water Filters

Source: Perm Polytechnic Department of Strategic Communications

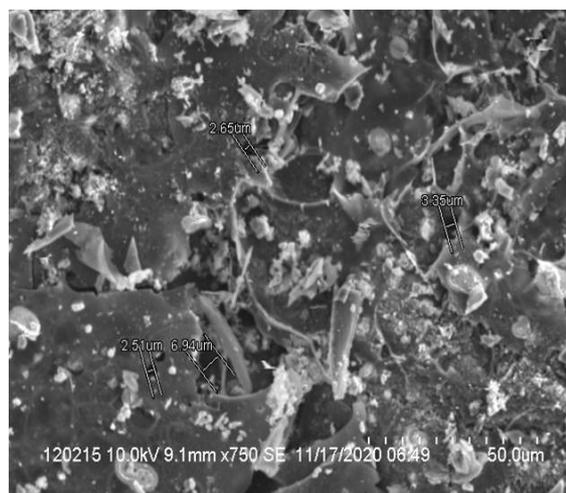
A group of scientists from the Perm Polytechnic Institute proposed a method for processing laminated plastics to obtain carbon sorbents. They can be used to purify wastewater from dissolved petroleum products and toxic compounds. According to the researchers, a lot of polymer waste is generated every year in the world. In particular, in Russia in 2018, their number amounted to more than 3.5 million tons, and about 12% was processed. The scientists published the results of the research in the journals "Ecology and Industry of Russia" and "Sorption and Chromatographic Materials".

- Polymer materials are widely used in many areas, so it is necessary to safely dispose of and recycle their waste. Most often these are polyethylene, polypropylene, PET waste and composite polymers. These include laminates that contain phenol-formaldehyde resins. Now they are mainly buried at landfills for municipal solid waste. But they occupy large spaces and emit toxic substances: phenol, benzene and formaldehyde, "says **Irina Glushankova**, professor of the Environmental Protection Department of the Perm Polytechnic Institute .

Compressed laminates contain various materials that are interconnected by fillers: fabrics, paper or wood chips. In particular, these include chipboards and textolite. Now such waste is disposed of at MSW landfills, recycled or incinerated. But these methods are unsafe,

ecologists believe: in natural conditions, plastics decompose for a very long time, and during processing they release hazardous substances into the environment.

Scientists of the Perm Polytechnic University used the method of low-temperature pyrolysis for the processing of laminated plastics. The decomposition reaction of waste in this case takes place without oxygen. Pyrolysis produces carbon residues and gases that can become liquid fuels. The carbonaceous component can also be used as a fuel or water purifier, the researchers said.



Electron microscopic image of the surface of the pyrolysate containing catalytic additives

- To obtain products with the desired properties, the reaction process can be controlled using catalysts. We processed PCBs and chipboards in a laboratory oven using an alkaline reagent and catalytic additives - nickel salts or copper salts. As a result, we were able to determine the most effective conditions for obtaining a carbon sorbent with the required porous structure and

sorption properties, explains **Irina Glushankova.**

Scientists have obtained a carbon sorbent in one stage. According to ecologists, its absorption properties are not inferior to well-known analogues, for example, active coals of the AG-3 and BAU brands. Sorbents can be used to remove dissolved oil products and toxic aromatic compounds from wastewater.

Environmentalists have found that nickel and copper in carbon sorbents give them bactericidal and disinfecting properties. This allows them to be used for deep purification or post-treatment of waste water or river water.

19. The fifth launch of OneWeb satellites from Vostochny is a success

Source: ROSCOSMOS

A successful launch of 36 OneWeb satellites aboard the Soyuz-2.1b launch vehicle with the Fregat upper stage was executed on Thursday, July 1, from the Russian cosmodrome Vostochny. The launch of the spacecraft was carried out under the contracts of Glavkosmos (a subsidiary of Roscosmos) by the European launch services provider Arianespace (operates the launch of OneWeb spacecraft with the use of the Soyuz launch vehicle) and the company Starsem.

This launch became the fifth fully commercial launch of spacecraft from Vostochny. It was executed by the joint team, which combined the specialists of Roscosmos enterprises - Progress Space Rocket Center, Lavochkin Association,

TsENKI, Russian Space Systems, Glavkosmos and those of the foreign customers.

The separation of the Fregat upper stage from the third stage was nominal. During three and a half hours in accordance with the flight sequence, the spacecraft were separated from the upper stage nine times and injected into target orbits.

The foreign customers of Glavkosmos have confirmed that the company has fully complied with its contractual obligations. The customer has acquired the signal from all the satellites.

OneWeb low Earth orbit satellites are designed to provide consumers on the ground with high-speed Internet. Today's launch brought the number of OneWeb satellites in orbit to 254 and the company is planning to launch hundreds more.

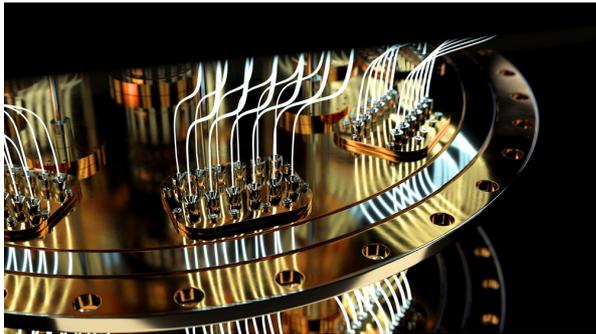
20. Scientists Discover New Type of Quasiparticle

Source: National University of Science & Technology, 29 June, 2021

Russian scientists have experimentally proved the existence of a new type of quasiparticle — previously unknown excitations of coupled pairs of photons in qubit chains. This discovery could be a step towards disorder-robust quantum metamaterials. The study was published in Physical Review B.

Superconducting qubits are a leading qubit modality today that is currently being pursued by industry and academia for quantum

computing applications. However, the performance of quantum computers is largely affected by decoherence that contributes to a qubits extremely short lifespan and causes computational errors. Another major challenge is low controllability of large qubit arrays.



Metamaterial quantum simulators provide an alternative approach to quantum computing, as they do not require a large amount of control electronics. The idea behind this approach is to create artificial matter out of qubits, the physics of which will obey the same equations as for some real matter. Conversely, you can program the simulator in such a way as to embody matter with properties that have not yet been discovered in nature.

Arrays of superconducting qubits are generally described by the Bose-Hubbard model. An interesting feature of the Bose-Hubbard model is the emergence of bound boson pairs (doublons) caused by the strong quantum nonlinearity. The topological physics of doublons has been extensively explored in a series of recent theoretical works. However, the experimental investigation of topological properties of bound photon pairs is still lacking.

A group of scientists from NUST MISIS, Russian Quantum Center, ITMO University, Bauman Moscow State Technical University, Dukhov Automatics Research Institute (VNIIA) and Ioffe Institute used an array of superconducting qubits to engineer a quantum simulator. Quantum utilize entanglement and many-particle behaviors to explore and solve hard scientific, engineering, and computational problems.

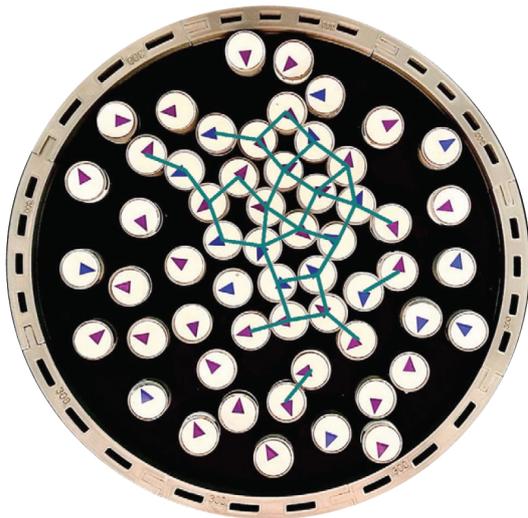
“By registering the properties of qubits, we can draw conclusions about a broader class of physical systems described by the same equations. And if we can change the parameters of these equations in a controlled way, then such a device can be considered a ‘specialized simulator’. Of course, its programmability is not the same as that of a quantum computer, but its scaling requires significantly fewer resources,” explains the main author of the study Ilya Besedin, junior researcher at the NUST MISIS Laboratory of Superconducting Metamaterials.

The scientists engineered an array of superconducting transmon qubits with alternating coupling. Due to the alternation of strong and weak bonds, two zones and an edge state appear in this system. This state is classified as topological. Moreover, the experiment shows that doublons also form an edge state.

“We were able to see how doublons form these zones, and we even managed to detect how an edge doublon state appeared at the upper edge of the doublon zone as we increased the length of the array,” notes Ilya Besedin.

21. Neural Network to Study Crowd Physics for Training Urban Robots

Source: National University of Science & Technology, 28 June, 2021



The chaotically moving objects dense clusters digital twin is being developed by students from NUST MISIS, ITMO and MIPT to navigate robots. It is going to be a web service using graph neural networks, which will allow studying the physics of crowds, the laws of swarm behavior in animals and the principles of “active matter” motion. This data is often required for educating courier robots, drones and other autonomous devices operating in crowded spaces. The first results were published in the Journal of Physics: Conference Series.

If, while moving in the flow of people in the subway, we begin to focus our gaze on someone from the oncoming traffic, we will definitely stop in the middle of the crowd and collide with somebody. When we walk through the crowd

relaxed, “intuitively”, then we unmistakably choose the desired trajectory and maneuver in the stream, without touching anyone. And almost every person can do it, because the brain works like a complex neural network. Imperceptibly for consciousness, he uses the intuitive knowledge accumulated over the years, quickly calculates the changing conditions and chooses the optimal path.

Modern engineers need to understand exactly how this neural network works to adopt its principles and integrate them into the digital environment. The task of navigating robots in dense clusters (people, cars, other robots, etc.) becomes more and more urgent every year. At the same time, for successful device management, it is necessary to track and extrapolate the trajectory of each individual agent in such clusters, which is a difficult task.

Such systems can be effectively described statistically as “active matter”, in which each particle itself pumps energy into the system, and successfully simulates such matter using ensembles of chaotically moving robots — for example, imitate the behavior of a flock of birds or a school of fish. To do this, one needs to create a simulation of active matter, i.e. to generate swarm behavior.

To implement such swarm robotics systems, numerous laboratories around the world need large “swarms” of robots moving according to simple laws — as platforms for experimental simulation of crowd physics. However, conducting such experiments requires significant resources and is not available to all scientific groups.

“Implementation of such an experimental platform requires competence in circuitry, and significant financial costs are required to create a sufficient number of structurally homogeneous robots. As an alternative, we propose the creation of an experimental unit digital twin, which allows both to eliminate the costs of its physical implementation and to speed up and automate the process of setting up experiments. The ability to effectively build such software is confirmed by recent applications of graph neural networks to similar tasks, including fluid dynamics simulations, ” said Vadim Porvatov, leader of the student research team, a graduate of the Department of Engineering Cybernetics at NUST MISIS.

According to the developers, an experimental unit assembled by the project team, consisting of 100 moving robots, is used as a data source for the neural network algorithm. The movement of the system is being recorded with a video camera. The algorithms provided by the OpenCV library will be used as the main tool for tracking individual trajectories. The information about the setup configuration, together with the trajectories obtained as a result of the movement of the robots, will be used to train the graph neural network.

“The developed neural network will allow scientific groups to significantly simplify the process of studying physical processes in dense clusters of chaotically moving particles and can be supplied as a product. Measuring all coordinates and velocities of robots will allow obtaining an exhaustive description of the processes occurring in the system, including information on phase transitions and clustering of robots,” explained Nikita Olekhno, co-author

of the study, a Ph.D. student at ITMO Faculty of Physics.

The use of the digital twin will enable industry research related to navigation in chaotic environments. For example, virtual simulations are already being used by NVidia to develop navigation algorithms for unmanned vehicles. The results of the work can be used to train control algorithms for ground drones moving in dense traffic. Simulations like these can be especially useful for testing courier robots.

“At the moment, a rather complex experimental unit has been assembled, and we will continue to use it to create a digital twin,” emphasized Nikita Olekhno.

“Research on superconducting qubits and quantum circuits is currently underway in many countries around the world, and competition in this area is growing. This study on 11 qubits shows that Russia has attained high level of scientific development in the field of superconducting quantum computing”, notes Prof. Alexey Ustinov, Head of the Laboratory for Superconducting Metamaterials at NUST MISIS and Group Head at Russian Quantum Center, who co-authored the study.

22. Stem Cell Transplantation to Help Stroke Patients Recovery



Source: *National University of Science & Technology, June 28, 2021*

A Russian-Canadian research has found that stem cell transplantation may help restore brain function in stroke patients. The study was published in *Frontiers in Neuroscience*.

Ischemic stroke, also known as brain ischemia and cerebral ischemia, is caused by a blockage in an artery that supplies blood to the brain. Ischemic stroke is one of the prevailing causes of disability and death throughout the world, with over 450 000 cases registered annually in Russia alone. The immediate therapeutic objective for acute ischemic stroke patients is prompt and efficient restoration of blood flow to ischemic brain tissue. This can be achieved by administering a clot -busting drug in a process called thrombolysis or mechanical thrombectomy, a type of a minimally-invasive procedure in which an interventional radiologist uses specialized equipment to remove a clot

from a patient's artery. Both methods have limitations and are effective only if applied during a narrow "therapeutic window" after stroke onset, which is 4.5–9 hours for systemic thrombolysis and no more than 24 hours for mechanical thrombectomy. Moreover, even in the case of timely reperfusion therapy followed by the currently available neurorehabilitation, many patients suffer from life-long neurological deficits. It has been hypothesized that efficient ischemic stroke post-reperfusion treatment should include neuroprotection, control of neuroinflammation and autoimmune reactions, restoration of microcirculation and blood-brain barrier integrity, and enhancement of brain plasticity. Cell therapy is an emerging strategy with a potential to meet most of these requirements, as it has shown efficacy in brain restoration after the acute phase of stroke in animal models.

In their experiments, the scientists from the Pirogov Russian National Research Medical University, NUST MISIS and New World Laboratories used reprogrammed human neural precursor cells (NPC) and mesenchymal stem cells (MSC). NPCs generate neurons and glial cells and thus are obvious substitutes for the recipient's own ones eradicated or impaired by stroke. Moreover, both neural and mesenchymal stem cells produce different substances that promote brain tissue regeneration.

MSCs can readily be obtained from different sources, including the umbilical cord, cord blood, adipose tissue, and bone marrow. However, isolation of native human NPC directly from fetal or adult brain is associated with serious technical, legal and ethical problems, alternative methods of their

production for preclinical studies and clinical needs have been developed. Currently, direct reprogramming of somatic cells is considered to be the safest way of NPC isolation.

“In this study, the cells were transplanted into rats intra-arterially 24 hours after the transient middle cerebral artery occlusion. Transient middle cerebral artery occlusion in rodents is one of the most widely utilized models in experimental stroke studies. The cells were transplanted intra-arterially to provide targeted delivery to the ischemic lesion and to bypass filtering organs, such as lungs, liver, spleen”, noted the lead author of the study Daria Namestnikova, neurologist, assistant professor at the Department of Fundamental and Clinical Neurology, Pirogov Russian National Research Medical University, senior researcher at the Federal Center of Brain Research and Neurotechnologies of the Federal Medical Biological Agency of the Russian Federation.

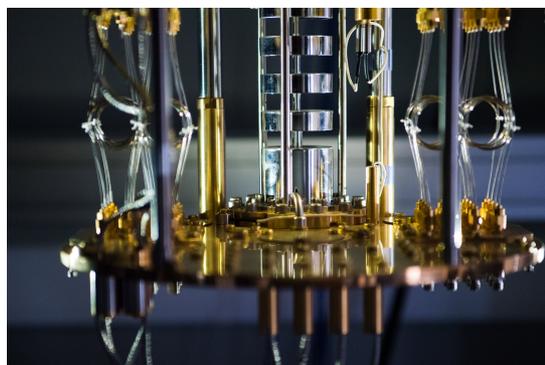
“For precise cell visualization in this study we used real-time MRI starting at the very onset of cell infusion. Immediately after transplantation, cells were observed in the periphery of the infarct zone and in the brain stem, 15 min later small numbers of cells could be discovered deep in the infarct core. Transplanted cells could no longer be detected in the rat brain 48–72 hours after infusion. However, the long-term survival of transplanted cells is not necessary for maintaining continued functional recovery. They may act through an indirect ‘trigger’ mechanism launching a cascade of molecular and cellular events promoting recovery. The positive therapeutical effects were still observed 14 days post-injection”, adds Maxim Abakumov, head of the NUST MISIS Biomedical Nanomaterials

Laboratory, senior researcher at the Medicinal Nanobiotechnology Department, N.I. Pirogov Russian National Research Medical University.

Transplanted cells secrete factors (e.g. growth factors) that signal the patient’s cells to change their behavior to repair the damaged tissue, in a process called the paracrine effect. In animal stroke models, transplanted NPC most likely influenced brain neural, glial and immune cells and enhanced brain tissue protection and regeneration via secretion of cytokines, growth factors and other biologically active substances.

23. Scientists Got Photons to Interact, Taking Step Towards Long-Living Quantum Memory

Source: National University of Science & Technology



An international research team obtained experimental evidence for effective interaction between microwave photons via superconductive qubits for the first time. The study, published in npj Quantum Materials, may be a step towards the implementation of a long-

living quantum memory and the development of commercial quantum devices.

Scientists believe that individual light particles, or photons, are ideally suited for sending quantum information. Encoded with quantum data, they could literally transfer information at the speed of light. However, while photons would make for great carriers because of their speed, they don't like to interact with each other, making it difficult to achieve quantum entanglement.

A team of scientists from NUST MISIS, Russian Quantum Center, the Ioffe Institute St. Petersburg and Karlsruhe Institute of Technology, for the first time, made photons interact with each other effectively using an array of superconducting qubits and a waveguide. In their experiments, the researchers used photons with the frequency of a few GHz and the wavelength of a few centimeters.

“We used superconducting qubits, which are basically artificial atoms, because they have been proven to strongly interact with light. Interaction between natural atoms and natural light is weak due to the small size of natural atoms. Superconducting qubits are man-built, their size can reach up to 0.1mm, which makes it possible to significantly increase their dipole moment and polarity, engineering strong interaction between light and matter,” noted Prof. Alexey Ustinov, Head of the Laboratory for Superconducting Metamaterials at NUST MISIS and Group Head at Russian Quantum Center, who co-authored the study.

Superconducting qubits are a leading qubit modality today that is currently being pursued

by industry and academia for quantum computing applications. However, they require milli-Kelvin (mK) temperatures to operate. The most powerful of the existing superconducting quantum devices contains under 100 qubits. As you add qubits, the number of operations a quantum computer can perform grows exponentially, but the maximum number of qubits that can be integrated in a quantum computer is limited by the size of refrigerators used to cool them down to operational temperatures. Taking this into account, the efforts of the scientific community have been recently focused on increasing the processing power of a quantum computer by transmitting quantum signals from one refrigerator to another. To engineer this transmission, the scientists coupled an array of eight superconducting transmon qubits to a common waveguide — a structure that guides waves, e.g. light waves.

“By employing dedicated flux-bias lines for each qubit, we establish control over their transition frequencies. It was derived and experimentally verified that multiple qubits obtain an infinite range photon mediated effective interaction, which can be tuned with the inter-qubit distance,” says Alexey Ustinov.

The circuit of this work extends experiments with one and two qubits toward a full-blown quantum metamaterial, thus paving the way for large-scale applications in superconducting waveguide quantum electrodynamics.

24. Recent Research / Innovation Initiatives at Tomsk Universities

(i). Scientists have found new parasites in bats from Asia

Source: Tomsk State University News, 17 May 2021

A group of scientists from TSU and Moscow State University identified and described a new species of mites parasitizing bats, *Spinturnix tylonycterisi*, which are new for Vietnam. In addition, they found links between parasites and hosts that are considered uncharacteristic. The new data are important for understanding the pathways of spread of dangerous infections transmitted by ticks and bats. The biologists' research has been published in the highly-ranked *International Journal of Acarology* (Q1).

Among the new interesting finds is a new host for the mite *Eyndhovenia euryalis*. This species was found on a long-toed bat (a member of the smooth-nosed family) caught in Japan. Traditionally, it parasitizes on a completely different family - the horseshoe noses involved in the spread of the SARS-CoV2 virus, which the whole world is currently experiencing in a pandemic.

This once again confirms the active contact between representatives of different taxonomic groups of bats. The facts of parasite exchange revealed by biologists show new possible ways of spreading infections, which is important for forecasting epidemics and taking preventive measures.

(ii). TSU creates a catalyst to protect the atmosphere from emissions

Source: Tomsk State University News, 13 May 2021

A group of scientists at the TSU Laboratory of Catalytic Research (LCR) has created a new multi-functional material that combines the properties of a sorbent and a catalyst and will help solve environmental problems. The new catalyst is capable of capturing and neutralizing toluene, benzene, methanol, and other hazardous substances from industrial discharges and exhaust gases from vehicles. The new material is a combination Ag-CeO₂/ SBA-15 (silicon oxide with an ordered structure), which does not contain expensive metals (platinum, palladium, and gold), but at the same time enables trapping and subsequent neutralization of harmful substances much more efficiently. These competitive advantages expand the possibilities of using the new material to limit emissions of harmful substances into the air.

This problem is especially urgent during the cold start of a car engine, when the greatest amount of hazardous substances is released into the environment, - explains Grigory Mamontov, the project manager, senior researcher at LCR. The material helps to capture these compounds at ambient temperature, and then neutralize them to harmless substances during the subsequent heating of the catalytic unit of the car to 150–250°C. This approach can also be used to remove volatile organic compounds from industrial waste gases. The catalysts developed in the course of fundamental research can be adapted to the specific practical task of air purification.

It should be noted that dirty air increasingly leads to respiratory, infectious, and cardiovascular diseases, and many other pathologies in children and adults. The use of new technologies and products can significantly reduce its negative impact on the environment and human health.

(iii). Twisted particles could give physics a new trend

Source: TSU News, 21 May 2021

The TSU physicist mathematically proved that twisted particles retain an unusual quantum state and exhibit wave properties when reaching high speeds, while ordinary particles do not exhibit wave properties. These calculations, in an experiment at a modern collider, could lead to a new trend at the intersection of particle physics, accelerator physics, and quantum optics.

Electrons, neutrons, photons, and other elementary particles can, under some conditions, exhibit the properties of waves, and under others, can exhibit the properties of particles. This phenomenon is called wave-particle duality. Under normal conditions, an electron exhibits wave properties only at low energies. So as a particle it can be considered only at high energies. However, recently physicists have learnt to twist electrons and neutrons, from which their characteristics change dramatically.

In the state of a wave, when an electron moves, its charge is uniformly smeared over a certain area, which is called the wave-front. Twisted elementary particles are those in which the wavefront is similar to the screw of a meat

grinder - that is, it rotates around the axis of the direction of their movement. Until now, scientists have been able to create such unusual quantum states of particles only with electron microscopes at moderate energies. Nevertheless, even this made it possible to significantly improve the quality of the analysis of the magnetic properties of nano-materials and opened up new possibilities for atomic spectroscopy and electron microscopy with a resolution of tenths of nanometers.

Dmitry Karlovets, Doctor of Physical and Mathematical Sciences, senior researcher at the TSU Laboratory of Theoretical and Mathematical Physics, theoretically proved the fundamental possibility of creating twisted particles at high energies using accelerators. He described the processes occurring with them using computer modeling and methods of mathematical physics.

If these ideas are realized in an experiment, it will help to create beams of twisted particles with enormous energy: hundreds and even thousands of times more than now, and not only light electrons, but also heavy protons, ions, and so on. This could give physicists new tools for analyzing the structure of compound particles - hadrons, atoms, and ions. In particular, twisted electrons with high energies would help to study the spin of a proton - one of the modern mysteries of high-energy physics, since the large orbital moment of such an electron will enhance the interaction with the spin of the proton and the angular moment of its constituent particles.

Beams of particles in unusual quantum states can provide new tools for analyzing the properties and structure of matter and the

properties of the particles themselves. Until now, experimenters have created classical beams of particles of various shapes, where each particle flew with its energy and in a certain direction. Quantum beams consist of particles, where each particle seems to fly in different directions at the same time. This property makes it possible to create new sources of pairs of so-called entangled particles, which is important both for the development of quantum optical communication technologies and quantum computers.

(iv). TPU scientists Study methane seep of the seas of the Eastern Arctic

Young scientists of Tomsk Polytechnic University (TPU), as part of a group of Arctic researchers, studied pore (silt) waters in three areas of methane release to the surface. In particular, they were the first to succeed in establishing in detail the composition of pore water in methane seeps in the seas of the Eastern Arctic.

The research was based on samples obtained during the Arctic expedition on the research vessel "Akademik Mstislav Keldysh" in 2019. In an expedition organized by the Institute of Oceanology named after P.P. Shirshov RAS in cooperation with the Pacific Oceanological Institute of the Far East Branch of the Russian Academy of Sciences.

Tomsk Polytechnics performed a number of scientific tasks, including the study of the state of bottom sediments and pore waters. Pore waters are interesting because they reflect both the composition of seawater and the composition of sediments. Studying them from

the point of view of geo-chemical, biochemical and hydro-chemical data, it is possible to reconstruct the processes occurring in water and sediment, as well as to predict the development of the situation.

“During the expedition, we focused on the points of methane release and changes in hydro-geochemical properties in these places. A total of six cores and 42 pore water samples were taken at depths ranging from 22 to 68 meters. The main emphasis was placed on the places where methane is released to the surface. Thus, three areas were studied, each with its own characteristics: the Lena River delta, the continental slope of the Laptev Sea and the central part of the East Siberian Sea. In fact, we were comparing three vultures. In addition, samples were taken at background points in the immediate vicinity of the methane release to the surface,” says one of the authors of the article, a researcher at the Department of Geology of TPU Yulia Moiseeva .

When taking samples, the scientists used special filters and vacuum tubes to exclude the ingress of oxygen and get reliable results. Some of the analyzes were carried out directly on board the ship. For example, rapidly changing indicators were studied - biogenic elements (nitrates, nitrites, phosphates, ammonia), total alkalinity. A more detailed study of the samples continued in the laboratories of the Tomsk Polytechnic Institute.

“Returning from the expedition, we studied the macro- and micro-component composition of pore waters, which was carried out in the accredited problem research laboratory of hydrogeochemistry at TPU using inductively

coupled plasma mass spectral analysis. For each sample, data on 66 elements were obtained, which allowed us to identify geochemical indicators of the presence of seep: which elements in this case may be in higher or lower concentrations in comparison with background concentrations, "explains Daria Purgina, a researcher at the TPU Geology Department .

Thus, the scientists were able to identify the regional features of the seas of the Eastern Arctic, including for areas confined to the outcrops of vultures. For example, stations located in the East Siberian Sea are characterized by an increased content of manganese, aluminum, silicon, phosphorus, iron, copper and barium in comparison with the Laptev Sea, where there was an increased content of lithium, boron, vanadium, bromine, uranium and a low content of iodine. and manganese.

In general, in the methane emission zones, the concentrations of vanadium, thorium, phosphorus, and aluminum are increased, while the concentrations of cobalt, iron, manganese, uranium, molybdenum, and copper are generally low.

"Thus, we have pre-installed a number of elements that can be used as indicators of methane yield. To confirm the results, studies are continuing, and extended data have already been received on the results of the 2020 Arctic expedition. Now the materials are being processed, but we can already say that some of the new data confirm the previously obtained results. In addition, the expanded database will make it possible to reconstruct in more detail the processes occurring in the methane outlet zone.

The uniqueness of the data obtained lies in the use of modern sampling methods that minimize errors, as well as in obtaining a wide range of elements with high accuracy. In general, the pore waters at the sites of seep outcrops in the Eastern Arctic have not yet been studied in such detail and comprehensively, "the scientists summarize.

(v). TPU scientists have created high-quality and cheap gasoline from gas production waste

Scientists of Tomsk Polytechnic University have developed a technology for the production of high-quality motor gasoline grades AI-92, AI-95 and AI-98 from gas by-products. The new technology is simple and will help oil and gas producers to provide themselves with fuel.

Stable gas condensates (SGC), are most often mixed with oil to improve its fluidity and facilitate transportation. However, SGK are a valuable hydrocarbon feedstock. And it is possible to use them more efficiently by processing high-octane gasolines into components on a zeolite catalyst.

Studies by TPU chemists have shown that processing on zeolite allows increasing the octane number of SGK by an average of 18 points, that is, in fact, getting AI-80 gasoline in one technological stage. Scientists also proposed formulations for mixing commercial gasoline grades AI-92, AI-95, AI-98 based on SGK processing products.

We have established the directions for the conversion of hydrocarbons that make up the SGC, and also determined the influence of the

processing parameters on the composition and characteristics of the products obtained. This will allow you to select the optimal parameters for the most efficient use of condensates of various compositions. The technology proposed by scientists can allow mining enterprises to produce fuel not only for their own needs, but also provide them with a certain territory. This may be relevant for the north of Russia, where many mining companies operate. At the same time, the delivery of fuel to remote enterprises significantly increases the cost of products.

The refining process, the authors of the article note, does not require hydrogen-containing gas and special preparation of raw materials, which allows it to be carried out even in low-tonnage performance outside large oil refineries. The advantages of the technology are also associated with the catalyst used, zeolite. Zeolites are inexpensive minerals that do not contain precious metals and are resistant to catalytic poisons. In the proposed work, for the first time, the processing of stable gas condensates on a zeolite of the ZSM-5 structural type is realized.

At the same time, the Compounding software complex developed at TPU was used to develop formulations for mixing gasolines and assess their detonation resistance. The next stage of the work will be the creation of a mathematical model for accurate prediction of the composition and characteristics of the products obtained.

(vi). TPU Scientists Amplified Signal of Spectral Passport of Molecules for Biomedical Applications

Source: TPU News, 07 May 2021

TPU researchers have developed and studied the properties of various types of substrates that are promising for in vivo monitoring of chemicals. To amplify the signal and increase the sensitivity, SERS (surface-enhanced Raman spectroscopy) substrates are used, made of noble metal nanoparticles. With the SERS method, the signal is amplified when light with a specific wavelength is incident on the nanoparticles.

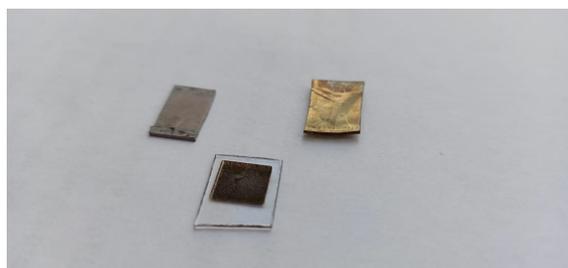


Photo:examples of SERS substrates developed at TPU

According to scientists, in many areas of medicine, the individual characteristics of the patient's body and the disease are significant? the degrees determine the success of the treatment. For example, when determining the effectiveness of cancer treatment or the level of drugs with high intra-individual variability. At the same time, the existing methods of analysis have a long response time, high cost and are often unable to provide in vivo monitoring. Within the framework of the project, scientists proposed using SERS-substrates, since this approach has a high chemical specificity, and its signals are less susceptible to the influence of nonspecific adsorption of proteins.

Scientists have been engaged in development and optimization of SERS-substrates that could be implanted for long-term in vivo monitoring, as well as their testing in model experiments to solve problems of oncology and pharmacology.

Scientists have made substrates based on a photonic crystal, hexagonal carbon nitride, polyurethane, and polyethylene terephthalate (PET). Nanoparticles of noble metals - gold and silver - were deposited on them. Four methods were used for deposition: electrochemical, nanospheric lithography, chemical functionalization, and laser integration. The resulting samples were studied using spectroscopic methods and compared with each other to determine which one is stronger, more flexible, gives the best sensitivity, is easier and more economical to manufacture.

“It is not enough to obtain a substrate, it is necessary to develop a measurement technique that can be transferred to such a complex system as a living organism, to show the perspective of the approach. As a result of our research, we came to the conclusion that the most promising is a substrate based on a biostable polymer, polyethylene terephthalate (PET), coated with silver nanoparticles fixed by laser integration. And we focused on experiments with these substrates, using a marker molecule whose Raman spectrum is sensitive to pH changes, and obtained spectra reflecting changes in the cell growth environment in SERS. A change in pH can be an indirect sign of the presence of a pathological process, such as a cancerous tumor,” explains the scientist.

Scientists from the Research School of Physics of High-Energy Processes, the Research School

of Chemical and Biomedical Technologies, the Engineering School of Natural Resources, the Research Institute of Pharmacology and Regenerative Medicine, and the Research Institute of Oncology of the Tomsk Research and Development Center took part in the study.

(vii). A device with nanosensors for detecting early signs of sudden cardiac death was developed at TPU

Source: TPU News, 14 May 2021

Scientists of Tomsk Polytechnic University have developed a hardware-software complex based on nanosensors for measuring heart micropotentials in real time without filtering and averaging cardiocycles. The device allows you to register early pathological changes in the work of the cells of the heart muscle, which otherwise can be recorded only during open-heart surgery or by inserting an electrode into the heart cavity through a vein. Such changes can lead to sudden cardiac death. In Russia and in the world, there are no analogues to the Tomsk device for a number of key characteristics today. The results of four years of measurements of micropotentials with this instrument with the participation of a volunteer are published in the journal *Measurement* (IF: 3.364; Q1).

The heart is constantly generating electrical signals. They cause the heart muscle to contract and help the heart to function as a pump. By the shape and duration of these impulses, one can judge the state of the heart. The main method of recording electrical impulses, which is used everywhere, is electrocardiography (ECG). But modern ECG devices already record critical

changes in the work of the heart muscle - the myocardium.

“Therefore, there is an acute issue of creating tools for the early diagnosis of these disorders, when the work of cells can be restored with medication, without surgical intervention. To do this, you need to fix the energy of micropotentials — electrical signals emitted by individual cells. But how can this be done non-invasively? Our team has been working on this problem for a long time, as a result, with the participation of medical colleagues, we have developed a software and hardware complex.

The essence of its work is similar to the ECG, but we changed the sensors: we made nanosensors instead of conventional sensors and were able to measure signals of the nanovolt and microvolt levels without filtering and averaging over a wide frequency band. The use of nanosensors led to the need to apply original circuitry solutions and write their own software.

As a result, we got a colossal difference in sensitivity, ”says Diana Avdeeva , scientific leader of the project, head of the TPU Medical Engineering laboratory .

The complex consists of a set of sensors (sensors), a compact main device for recording incoming signals from sensors and software for data processing. The sensors are attached to a person's chest using a standard conductive gel. The monitoring procedure takes about 20 minutes.

Standard electrocardiographs operate at frequencies from 0.05 to 150 hertz, the device of

Tomsk scientists - at frequencies up to 10,000 hertz.

“For high-quality ECG recording, silver chloride electrodes are usually used. Our sensors are also silver chloride. But we used silver nanoparticles. Each of our sensors contains up to 16 thin plates of porous ceramics, in these pores are placed silver nanoparticles. One sensor contains millions of particles, each of which is a silver chloride nanoelectrode capable of amplifying the heart's electric field. Silver and gold nanoparticles are capable of amplifying the electromagnetic field: visible light by 10,000 times, infrared radiation by 20 times. We also abandoned the use of filters to suppress network interference and noise, which are usually used in standard ECGs and significantly distort micropotentials, ”says Diana Avdeeva.

The published article presents data from monitoring the work of the heart of one volunteer. For four years, he participated in research and was monitored every 7-10 days.

“At the beginning of our study in a volunteer, we recorded clear violations of the myocardial cells. His attending physician recommended an operation to him, and a stent was installed at the Research Institute of Cardiology. Then he continued to participate in the research, and the device recorded a further gradual restoration of the work of the heart, ”the scientist notes.

Earlier, the project of scientists was supported by the technology platform "Medicine of the Future" and the federal target program. The complex was created in partnership with the specialists of the Research Institute of

Cardiology of the Tomsk NIMTs, the industrial partner was the Moscow enterprise NPO Ekran.

“The task was to create a sensitive, compact and affordable complex, so that in the future, polyclinics and home users could afford it. In addition, the developed methods and tools can be used not only in cardiology.

The directions of any electrophysiological research, such as electroencephalography, electromyography, and so on, are promising. But, of course, before implementation in cardiology, we need to go through several more important stages. This is the collection of the required array of statistical data, certification of the complex for medical use. All these stages require funding, we are now looking for partners and supporting programs, ”says Mikhail Yuzhakov, a member of the research team, an engineer at the Medical Engineering laboratory .

(viii). Network Master's Program in Hydrogen Technologies May Launch in Russia in 2022

Source: TPU News

Russian universities and research organizations that are part of the Hydrogen Technologies Consortium plan to launch an online Master's program in hydrogen technologies in 2022. The possibilities of creating such a program and other areas of the consortium's work were discussed on Friday at the first meeting of the Consortium's Supervisory Board.

Representatives of federal and regional executive authorities, industrial companies,

universities and scientific organizations took part in the meeting of the council.

“In 2021, the work of the consortium will be focused on developing a general research program for our organizations and on formalizing the position of the consortium in the format of an analytical report on the development of hydrogen technologies.

And next year, opportunities are being considered to enter the regions on pilot sites together with companies and launch a network magistracy. Because no university in the world can single-handedly launch a full hydrogen education program on its basis, ”

- said at the meeting the Acting Rector of TPU, co-chairman of the Coordination Council of the consortium Andrei Yakovlev .

The consortium of hydrogen technologies was created in Russia at the end of 2020. Then the founders and its first participants were the Institute of Problems of Chemical Physics RAS, Institute of Catalysis SB RAS, Institute of Petrochemical Synthesis RAS, National Research Tomsk Polytechnic University, Sakhalin State University, Samara State Technical University. The consortium also includes ITMO, Ural Federal University, Kazan State Power Engineering University, Kazan National Research Technological University, Russian Chemical Technical University named after V.I. DI. Mendeleev, Federal Research Center of Chemical Physics named after V.I. N.N. Semenova, Institute of Oil and Gas Problems of the Russian Academy of Sciences, Tomsk Scientific Center of the Siberian Branch of the Russian Academy of Sciences, the

Institute of High-Current Electronics of the Siberian Branch of the Russian Academy of Sciences, and others.

Russian companies such as SIBUR, Russian Railways, Severstal, Transmashholding, Rosatom, Gazprom Neft, TMK and others have confirmed their participation in the Council of Industrial Partners of the consortium.

(ix). TPU and EFKO will open a laboratory for technologies for food production

Source: TPU News, 17 May 2021

The EFKO group of companies is equipping a new microbiological laboratory at the Tomsk Polytechnic University. It will host practical classes for chemistry students, and scientists will develop technologies for food production. It is planned that the laboratory will be equipped by the end of the jubilee year for TPU in 2021 - the university celebrates the 125th anniversary of its foundation. The company estimates the amount of investment at 1.7 million rubles.

On Monday, EFKO Group Executive Director Sergei Ivanov took part in the opening of the international conference "Chemistry and Chemical Technology in the 21st Century" at TPU and presented the university representatives with a certificate for equipping the laboratory. It will be located in the chemical building of the Tomsk Polytechnic Institute (building No. 2).

"The laboratory at the Tomsk Polytechnic University will allow us to work out processes

in miniature, which can then be scaled up in our innovation center and then in production,

- commented the executive director of EFKO Group Sergey Ivanov . - Areas that we are interested in are alternative proteins, fat synthesis and the widespread use of biotechnology, including fermentation in food production. We see TPU as one of our flagship universities in training specialists for us. And, of course, it is a great honor for us to have the opportunity to congratulate the university on its 125th anniversary. "

The laboratory will hold practical and laboratory classes for bachelors who study under the program "Analytical control in the chemical industry", and for undergraduates - the program "Analysis and control in chemical and pharmaceutical industries" (module "Analysis and control in food microbiology"). These are future specialists for the chemical, food and pharmaceutical industries.

"The laboratory will perform two functions: educational and scientific. On the research agenda, we, as an industrial partner, are interested in the synthesis of new proteins and enzymes. And from the point of view of education, together we will train specialists who will feel confident in a changing world and will be able to make a real contribution to the development of technologies in such a strategically important direction as food production ",

The laboratory will be created on the basis of the existing TPU laboratory fund and will be supplemented with specialized equipment. For

example, a CO₂ incubator for the cultivation of microorganisms will appear at the university.

With the help of the new equipment, the polytechnics will develop technologies for obtaining enzymes used in the food industry, for example, phospholipases, using bacteria. Scientists will develop technologies not only for the isolation of enzymes, but also for their purification and quality determination.

EFKO specialists are already taking part in students' scientific and practical work, and TPU students, together with teachers, are looking for anaerobic bacteria for the utilization of fiber and sugar in meal - a by-product of the extraction of oils from plant seeds.

As a reminder, Tomsk Polytechnic University and the EFKO Group of Companies signed a cooperation agreement in the fall of 2020. TPU students undergo practical training in the innovation center "Biryuch", owned by "EFKO", the company's specialists participate in scientific projects of polytechnics, and a lounge area for students will be equipped in the chemical building of TPU.

(x). Laboratory of automated control systems opened at TPU

Source: TPU News, 04 June, 2021

A new laboratory of automated control systems has been equipped at the Tomsk Polytechnic University. In it, students in thermal power engineering will learn to simulate thermal processes, master high-speed thermal measurement technologies and design elements and blocks of control systems.

The laboratory was equipped within the framework of the VIU project by an interdisciplinary team of the School of Engineering and the Research School of Physics of High-Energy Processes with the support of the EleSy-Pro company and the Darmstadt Technical University.

"The laboratory is primarily intended for studies of masters in heat and power engineering. At the same time, it makes it possible to implement two trajectories for training specialists - engineering and scientific, including in English. For this, leading scientists from world scientific centers and specialists from enterprises of the high-tech sector of the economy were involved. This will allow TPU to train internationally demanded personnel in the field of automation of technological processes and promising eco-energy technologies," explains the project manager, professor at the Scientific and Educational Center. I.N. Butakova Pavel Strizhak .

For the work of students in the laboratory, four virtual complexes were developed. They will allow you to practice skills in 3D assembly of an automation switchboard, optical methods for diagnostics of steam and gas flows, process control at the SCADA level, design the structure of automated process control systems and simulate the computer-aided design of standard electrical connections in an automation switchboard.

The specialists of "EleSi-Pro" and TPU jointly developed virtual laboratory and practical works with the possibility of remote access to them. In addition, the industrial partner equipped the audience with three automation panels with

modern domestic and foreign equipment, including programmable logic controllers, analog and discrete signal converters, routers, as well as licenses for SCADA-Infinity software.

“The interaction of Tomsk Polytechnic University with the Darmstadt Technical University will allow integrating the best practices in the field of fluid dynamics to develop students' skills in designing and developing automated systems. At present, several applications for the joint implementation of international scientific projects of scientists of the Tomsk Polytechnic Institute and colleagues from Germany are under consideration. This will allow, on the one hand, to increase the number of joint scientific research, and on the other, to attract TPU undergraduates to work on scientific projects in Russia and abroad with full immersion in the English-speaking environment, ” Pavel Strizhak is sure .

(xi). Scientific and educational center of oil and gas chemistry and technology opened at TPU

Source: TPU News, 02 June, 2021

On the basis of the Engineering School of Natural Resources of the Tomsk Polytechnic University, a subdivision was opened, which will combine a wide range of areas and will allow to perform more work in the interests of the industrial partners of the university.

According to Natalya Guseva, director of the School of Natural Resources, the opening of a new center in the school structure and the liquidation of the testing scientific and

innovative laboratory "Drilling flushing and grouting solutions" is due to the expansion of the competencies of the employees.

“Now the laboratory staff are working in new areas of research and can solve a much wider range of problems. This will allow ISHPR to strengthen interaction with industrial partners and positioning in the service market, as well as to participate in larger projects where different competencies are required, ”says Natalya Guseva .



The new center was headed by Konstantin Minaev, head of the drilling and grouting fluid laboratory. Subdivisions of the center are located in buildings No. 19, 2 and the TPU Science Park. Industrial partners, JSC Tomskneft VNK, contributed to the repair and re-equipment of premises in the 19th building.

“First of all, I would like to thank the entire team, since this is a serious step towards rallying people to solve serious problems on the frontier of the oil industry. The opening of the center will expand the range of research and engineering work in the field of petrochemicals due to new and modern equipment,

interdisciplinary relationships and increased demand from industrial partners. This is a response to a request to break down barriers between university laboratories. It is important that the center opens up additional opportunities for students - they can choose a trajectory, enter the place where new projects are born, use the latest equipment, ”said Acting Rector of TPU Andrey Yakovlev at the opening of the center .



The Scientific and Educational Center for Oil and Gas Chemistry and Technology will unite five sectors: oilfield chemistry, drilling fluids, grouting fluids, reservoir physics, and chemistry of oil and oil products. The backbone of the staff will be laboratory staff, but new specialists will also be involved, as well as young scientists - undergraduates and postgraduates, including foreign ones.

“We can carry out large projects, we have gained experience that will allow us to comprehensively solve serious problems both in the scientific field and for industrial partners. I am sure that we have interesting work ahead of us, ”said the head of the center, Konstantin Minaev, to the staff .

It is planned that the center will carry out both scientific and industrial projects. However, the main emphasis will be placed on interaction with industrial partners. To complete the center under the program for updating the instrument base, high-quality equipment was purchased - a rheometer and a tensiometer worth more than 15 million rubles.

“TPU has not yet had equipment of this level for research in the field of oilfield chemistry. It will allow our employees to become participants in more serious projects in the interests of industrial partners, and students to master the latest devices during their studies, ”explained Konstantin Minaev .

In total, over 70 million rubles have been spent on the arrangement and purchase of various equipment for different sectors of the center for several years.

“Today we see the result of the cooperation path that our laboratories have gone through in terms of rapprochement, building relationships with each other. Now different divisions can say that they can jointly carry out large projects for the industry, ”stressed TPU Vice-Rector for Technological Development and Entrepreneurship Artem Boev .

25. Conversation on Predicting Natural Disaster

Source: RAS news, 31 May 2021

A special sensor helps to monitor the water level in rivers online. And predict the development of floods. This gives people time to take the necessary measures, and if necessary, then evacuate. Also, the sensor allows you to quickly check the reliability of ice crossings. The system for remote monitoring of water bodies has been developed and is being tested by scientists from the Limnological Institute of the Siberian Branch of the Russian Academy of Sciences. Director of the Institute, Doctor of Geological and Mineralogical Sciences Andrei Fedotov told the Rossiyskaya Gazeta correspondent about the capabilities of the new system.

Flood control radar

Andrey Petrovich, a radar-type sensor is a well-known device for a long time. What did you do to him that he turned into an invention?

Andrey Fedotov: Indeed, these sensors have been used for measurements in various fields for a long time. They send a radio signal, and, receiving a return pulse, fix the distance to the object. We were able to use the capabilities of the device much wider.

In our case, it measures the distance to the surface of the water. Together with weather stations and software developed by us, these simple devices have become part of automatic stations for monitoring the water level on rivers.

And how does it all work?

Andrey Fedotov: The sensor is installed above the reservoir near the monitoring point of the Roshydromet network. Suspended, for example, from a bridge. Power is supplied by a small solar battery. Then set up. And on the server of the Institute via a wireless communication channel online at intervals that are declared, up to minutes, the necessary indicators are received: water level in rivers, wind speed and direction, air temperature, humidity, presence and intensity of precipitation, atmospheric pressure. All data is automatically processed by a special program. And at any time online you can see from the office what is happening on the reservoir with its level.

What does all this give to those who live in flooded areas?

Andrey Fedotov: It is planned that the mathematical model, while processing the data obtained,

will predict further developments in the online mode. The water level in particular.

For example, mathematical calculations performed by Novosibirsk colleagues from the Institute of Computational Mathematics and Mathematical Geophysics of the Siberian Branch of the Russian Academy of Sciences for the Slyudyanka River showed that the reliability of forecasts for the next three days is quite high.

That is, in the event of a threat of a natural disaster, there is a margin of time for making administrative decisions, alerting the population and planning rescue operations.

Would this monitoring system help if it was installed on the rivers of Tulunsky and

Nizhneudinsky districts affected by floods in 2019?

Andrey Fedotov: Of course, it would not have been possible to prevent flooding and destruction of buildings. The problem here is in the hydraulic structures that could not withstand large water. But to avoid casualties by warning the population, it would be possible to have time to carry out the evacuation in time.

By air and under water

Where else would such a system be especially useful?

Andrey Fedotov: We also proposed to the government of the Irkutsk region to install sensors over the maps-accumulators of sludge-lignin of the former Baikal Pulp and Paper Mill. There is a risk of overflowing cards due to prolonged rains. Then the waste will go to Baikal. Using our system, all the cards are at a glance. And in case of an unfavorable prognosis, it will be clear in which specific place you need to apply preventive measures.

It turns out that on all potentially dangerous rivers near settlements your stations are simply needed?

Andrey Fedotov: The decision on the need for this type of monitoring is made by the local authorities. We can only talk about the effectiveness of automatic stations and the reliability of the readings.

Upon completion of open water availability, that is, when the reservoirs are covered with ice, test tests of three stations on the rivers in the Irkutsk

region and Buryatia - Irkut, Selenga and Barguzin will be completed. We will finalize the algorithm and report back. And those who make decisions will choose.

Can your station be installed on any body of water? Or are there some technical limitations?

Andrey Fedotov: Anything. We still use bridges - it's technically easier. And, you know, in a crowded place there is at least some guarantee that the vandals will not wear out. Unfortunately, they greatly interfere with scientific research.

And if you hide the sensors from them under the water?

Andrey Fedotov: We also have this kind of device. The problem is that on rivers, especially during floods, the apparatus can be damaged by currents and debris. Or it will blow away at all - you will not find it.

The equipment is expensive, we cannot afford its one-time use. But on the lakes – yes. We have installed such sensors on Lake Teletskoye and, of course, in different parts of Lake Baikal. And these sensors already provide us with interesting information and food for thought. Here, scientific work and monitoring of the state of lakes come out on top.

Instead of drill and tape measure

In winter, you tested another sensor - the under-ice sensor. And what is it for?

Andrei Fedotov: Scientists, of course, are interested in observing the process of ice growth, linking it with other natural phenomena.

But the under-ice sensor has a very practical purpose. It controls the thickness of the ice, ensuring the safety of ice crossings. After all, this process is still being carried out using the old-fashioned method. We took a drill, drilled a hole, measured it with a tape measure, and went on. With our system, you don't even need to go out into the cold - just sit and look at the monitor.

How many sensors do you need to install at one crossing to reliably monitor its safety?

Andrey Fedotov: This should be a network of sensors installed at a distance of up to 300 meters between them. I can say that this system has been fully worked out, it remains only to pass the certification of the ice station in the Customs Union.