



**Newsletter of the  
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***I. SCIENTIFIC ARTICLES & NEWS***

***II. INNOVATIVE PRODUCTS & SOLUTIONS***

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**SCIENTIFIC ARTICLES & NEWS**

**CONTENTS**

**PAGE NO.**

1. RUSSIA HAS LAUNCHED THE WORLD'S LARGEST PRODUCTION OF GRAPHENE NANOTUBES.....	04
2. ORGANIC LEDS MADE PLEASANT AND SAFE FOR THE EYES.....	05
3. CHEMISTS HAVE CREATED NANOMEDUSA FROM GRAPHENE AND AMMONIA.....	07
4. AGRONOMIST FROM SPACE.....	09
5. SCIENTISTS HAVE FOUND OUT WHAT MICROBES LIVE IN THE MOSCOW METRO.....	10
6. RUSSIAN SCIENTISTS EXPLAIN WHY PREGNANT BRAINS DO NOT ADAPT WELL.....	12
7. PERMAFROST WILL MAKE A QUARTER OF THE TERRITORY OF RUSSIA SUITABLE FOR AGRICULTURE.....	15
8. THE RUSSIAN PROJECT FOR THE STUDY OF THE SUN HAS RISEN IN PRICE.....	17
9. ISS ASTRONAUTS WILL TEST A 3D PRINTER AND A COATING ON PORTHOLES DEVELOPED IN TOMSK.....	18
10 SCIENTISTS EXPECT THAT SINCE 2022, PIONEER-M WILL BE ABLE TO GO TO SEA WITHOUT A CREW.....	19
11. RESEARCHERS AT MIPT AND PRINCETON SIMULATED A HIGH-VOLTAGE DISCHARGE IN FRONT OF A SUPERSONIC AIRCRAFT.....	21
12. SCIENTISTS HAVE IDENTIFIED FIVE POSSIBLE LANDING SITES ON VENUS.....	22
13. RUSSIAN SCIENTISTS CREATE QUANTUM MEMORY BASED ON MICROWAVE DEVICES.....	24
14. SCIENTISTS HAVE DISCOVERED AN UNKNOWN FORM OF CARBON IN THE CHELYABINSK METEORITE.....	25

15. SCIENTISTS HAVE FIGURED OUT HOW TO PROTECT THE BODY FROM ALL VIRUSES AT ONCE.....	27
16. RUSSIAN SCIENTISTS HAVE DEVELOPED A METHOD TO FIGHT CANCER WITH RUST.....	28
17. PHOTONIC INTEGRATED CIRCUITS (FIS).....	30
18. THE DIAMOND MATERIAL IS UNDER OUR FEET.....	31
19. "PHOENIX-2": TOMSK SCIENTISTS HAVE CREATED A DEVICE FOR TREATING BONE CANCER.....	34
20. SKOLKOVO RESIDENT SUCCESSFULLY TESTED THE BLOCKCHAIN ON THE ELBRUS PLATFORM.....	35
21. SAMARA SCIENTISTS HAVE DEVELOPED A COMPLEX FOR BRAIN RESEARCH .....	36
22. PLASMA AND FUSION RESEARCH. THE DEVELOPMENT OF NOVOSIBIRSK SCIENTISTS WILL HELP CREATE A NUCLEAR FUSION REACTOR.....	37
23. SCIENTISTS HAVE DISCOVERED A NUCLEOTIDE THAT CAN PROTECT THE BODY FROM OXYGEN STARVATION.....	38

## INNOVATIVE PRODUCTS AND SOLUTIONS

### CONTENTS

### PAGE NO.

#### ENERGY

1. INTELLIGENT RELAY PROTECTION WITH CHARACTERISTICS WHICH ARE INDEPENDENT OF OPERATONG MODES OF ACTIVE AND ADAPTIVE ELECTRICAL GRID.....	40
2. DESSIMILAR ENERGY SOURCES INTEGRATION DEVICE.....	41
3. DIGITAL TRANSFORMER SUBSTATION OF 10/0.4 KV WITH AUTOMATIC VOLTAGE AND POWER CONTROL.....	43
4. AUTOMATED UNIT OF TRAFFIC POWER FLOWS' CONTROL IN THE INTELLIGENT ELECTRICAL DISTRIBUTION NETWORK.....	45

#### VEHICLES

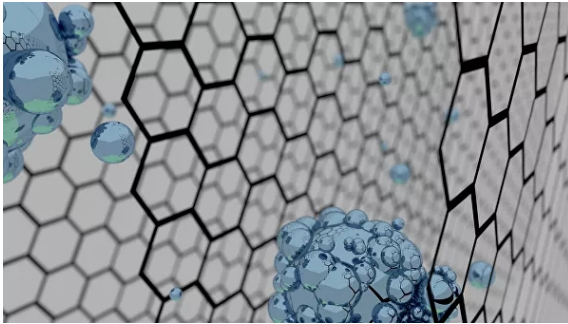
5. STAND-TIP FOR PASSIVE SAFETY EVALUATION OF VEHICLES BODIES.....	46
6. STAND WITH A PNEUMATIC BRAKE SYSTEM.....	47
7. TRANSPORTABLE CENTER OF VEHICLES TECHNICAL DIAGNOSIS.....	48
8. STAND-TIP FOR STATICAL STABILITY EVALUATION OF VEHICLES.....	49

9. USING NEURAL NETWORKS FOR PROBLEM SOLVING OF INDUSTRIAL EQUIPMENTS VIBRATION MONITORING AND FORECASTING OF WORKS TURNING QUALITY.....	51
10. COMPLEX FOR VEHICLES CHARACTERISTICS ESTIMATION.....	51
11. AUTONOMOUS MOBILE ROBOTIC SYSTEM .....	53
12. CROSS-COUNTRY VEHICLE ON LOW PRESSURE TIRES WITH AXLE CONFIGURATION .....	54
13. MULTIFUNCTIONAL CROSS-COUNTRY VEHICLE.....	56

### **METALLURGY & MATERIAL SCIENCES**

14. SAFETY, LIFE IMPROVEMENT AND REDUCTION IN METAL CONSUMPTION OF INDUSTRIAL EQUIPMENTS AND VARIOUS METAL STRUCTURES IN SERVICE.....	58
15. PRECISION COORDINATE NANOSYSTEMS ON THE BASIS OF AN INVERSE PIEZOEFFECT.....	59
16. RESEARCH AND DEVELOPMENT IN WHEEL WEBS REPAIR TECHNIQUE.....	61
17. CUTTING PROCESS DIAGNOSTICS IN REAL TIME.....	62
18. SOFTWARE PACKET FOR MATHEMATICAL SIMULATION THE PROCESS IN CHEMICAL POWER SOURCES.....	64
19. GETTER MATERIALS FOR DEGASIFIERS.....	65
20. FUNCTIONAL MATERIALS OBTAINED WITH METHOD OF METALS AND NONMETALS POWDERS ROLLING.....	66
21. LASER MICROANALYSIS.....	68
22. COMPLETE GYRO SENSOR WITH ELASTIC MEMBERS, MADE WITH WHOLE BLANK OF 44 HXTIO STEEL TYPE.....	70

### 1. RUSSIA HAS LAUNCHED THE WORLD'S LARGEST PRODUCTION OF GRAPHENE NANOTUBES



The Russian company OCSiAl, which stood out from the Rusnano portfolio of companies, launched the Graphetron 50 in Novosibirsk, the world's largest plant for the synthesis of graphene nanotubes that radically changes the characteristics of various materials.

Graphetron 50 - the world's largest plant for the synthesis of graphene nanotubes - the second installation of the Novosibirsk producer of graphene nanotubes, OCSiAl. The production capacity of the installation is 50 tons of graphene nanotubes per year.

He noted that the “fantastic” properties of single-walled carbon nanotubes, which can be added to almost any material to increase their strength and electrical characteristics, are “the secret of a new era of human materials,” the scale and significance of which is still difficult to understand and evaluate.

"A 50-ton installation has been launched today. We are well aware that no company on Earth is capable of producing even one ton. Today, OCSiAl is a supplier to 75% of the largest technology companies in the world, which, unfortunately, prohibit naming their names," said Chubais. OCSiAl President Yuri Koropachinsky explained that last year the company was certified as a supplier for technology giants such as LG and Pirelli.

Single-walled carbon nanotubes are a universal nanomodifier that improves the mechanical properties, electrical and thermal conductivity of various materials. Thus,

the addition of 0.1% single-walled carbon nanotubes to aluminum doubles its strength, the addition of 0.01% to some plastics makes them electrically conductive, the addition of 0.001% to concrete makes it 50% stronger. The pilot industrial unit for the synthesis of single-walled carbon nanotubes Graphetron 1.0 was launched at the Novosibirsk Akademgorodok in late 2013. With the commissioning of the Graphetron 50, the Russian company will be able to produce up to 75 tons of nanotubes per year with the possibility of increasing to more than 100 tons per year.

## **2. ORGANIC LEDS MADE PLEASANT AND SAFE FOR THE EYES**

Russian scientists have created new materials and a prototype light-mitting device with a number of unique characteristics. This work was supported by the Russian Science Foundation and published in the journal *Chemical Communications*. The results obtained by the scientific team can be used to create compact and energy-efficient light sources.



**Source: Depositphotos**

Organic light emitting diodes (OLEDs) have significant advantages over currently most common semiconductor light emitting diodes (LEDs). The production of such devices is technologically simple, and light emitting surfaces based on them weigh very little and

have excellent flexibility. Thin film multilayer structures are used to create organic LEDs.

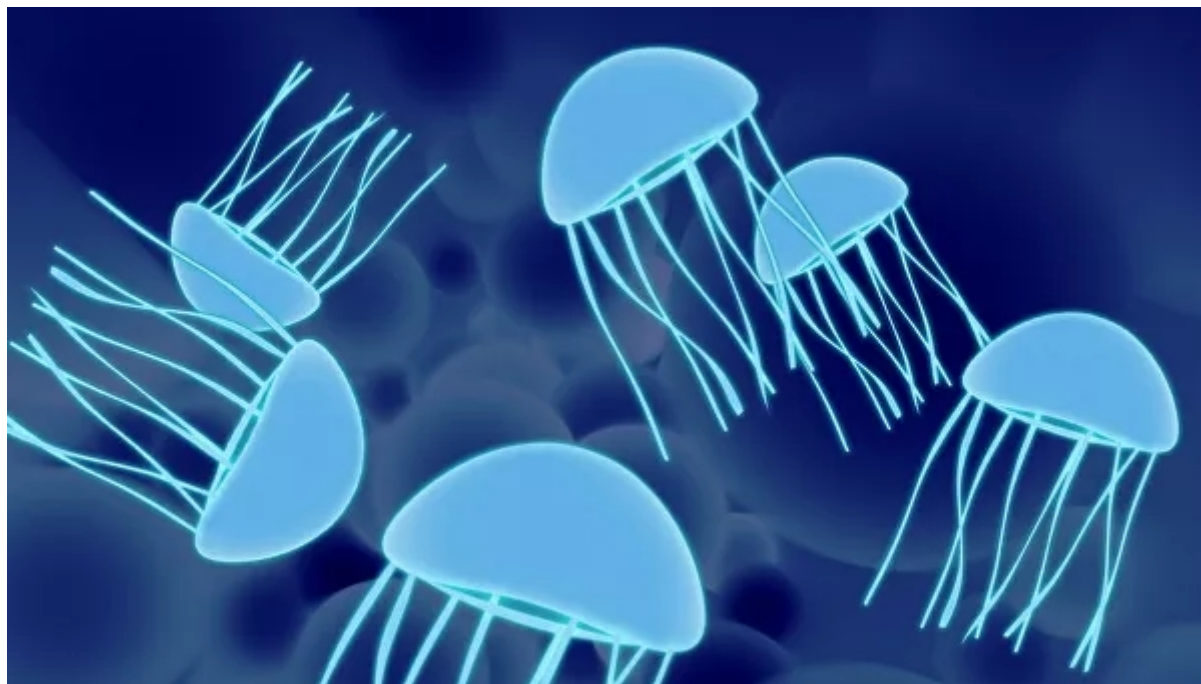
Today, white light from almost all high-quality sources, both LED and OLED, is formed from three colors (RGB - red, green and blue), and less high-quality ones - from a combination of two, usually blue and yellow. This leads to the fact that in the radiation of such devices there is always an excess of blue, which, as has been [proved by a](#) number of medical studies, negatively affects the human body as a whole and can cause damage to the retina of the eye. Therefore, scientists are faced with the task of creating safe sources of white light, similar in spectral composition to the usual light of the sun.

The scientific group, which includes researchers from the Physical Institute of the [Russian Academy of Sciences](#) named after P. N. Lebedev, Institute of Organic Chemistry of the Russian Academy of Sciences named after N. D. Zelinsky (laboratory of Prof. O. A. Rakitin) and Russian Chemical-Technological University named after D. I. Mendeleev (group led by Prof. I. Kh. Avetisov ), approached the solution to the problem. Scientists were able to synthesize special organic luminous dyes and select the remaining components of the auxiliary layers in such a way that at sufficient brightness (about 1000 cd / m<sup>2</sup>, which is about 4 times brighter than the standard monitor screen) OLED structures emit a pleasant to the eye and safe light, similar in spectral composition of the light of a candle or the sun at sunset. In this case, layers with blue light were not used. A significant advantage of the developed devices is the relative simplicity of the design - one radiating layer instead of 3-4, used in the RGB scheme. The thermal temperature of the LED can be adjusted in a wide range by optimizing the composition of the layers and additionally by changing the power settings.

*"We got a record low color temperature of the LED while maintaining sufficient brightness. Moreover, we did not use the platinum group metals, which are currently the standard for color OLED displays and light panels, but replaced them with cheap analogs," commented [Ilya Taydakov](#), Doctor of Chemical Sciences, Leading Researcher at the Lebedev Physical Institute.- OLED technology continues to attract more and more attention as a wonderful alternative to existing light sources. In particular, many world experts see in OLED technology the near future of color television and adaptive architectural lighting technologies. "*



### 3. CHEMISTS HAVE CREATED NANOMEDUSA FROM GRAPHENE AND AMMONIA



Students and employees of the Faculty of Chemistry of Moscow State University named after M.V. Lomonosov synthesized and modified graphene nanoparticles in shape resembling jellyfish. They can be used for supercapacitors and batteries. The results are [published](#) in the journal Applied Surface Science.





Graphene is a single atom thick graphite layer consisting of hexagonal cells with carbon in the corners. It has long been used in nanoelectronics, as it has the highest conductivity. Physicists from Moscow State University have created a cross between graphene and graphite - "nanoscales" - particles with a diameter of 15-50 nanometers, consisting of 6-7 layers of graphene.

"Such materials have a very developed surface, so they can be used in the manufacture of electrodes for supercapacitors and batteries. At the same time, modifying their surface with nitrogen atoms helps to vary the electrochemical and absorption properties. They also have potential for use in catalytic processes and in the manufacture of conductive multicomponent polymers." , - the MSU press service reports the words of one of the authors of the work, Sergei Chernyak, a researcher at the Department of Physical Chemistry, Chemical Faculty Lomonosov Moscow State University Lomonosov.

For use in microelectronic and optical devices, such particles must be doped, that is, to distribute a small amount of impurities throughout the thickness of the material. But for use in catalytic processes, you can simply apply a few impurities only to the surface, which was done by physicists from Moscow State University.

Nanoscales were obtained by chemical vapor deposition on a magnesium oxide substrate at a temperature of 900 degrees Celsius, then they were washed from the substrate with perchloric acid. It was after separation from magnesium oxide that the flakes began to resemble domes. Then they were treated with nitric acid, after which their edges were covered with functional oxygen groups. Then these groups were converted into nitrogen flagella under the influence of ammonia or an aqueous solution of urea ( $(\text{NH}_2)_2\text{CO}$ ) at a temperature of 220 degrees Celsius.

The resulting structures resembled jellyfish, so the authors called them "jellyfish graphene nanoscales." The surface and structural change of the samples were studied using scanning and transmission electron microscopes, Raman and X-ray photoelectron spectroscopy. Interestingly, the structure of nanoscales did not change due to the low temperature at which exposure to ammonia or urea was carried out.

#### **4. AGRONOMIST FROM SPACE**

Samara scientists have created a program that predicts the harvest and advises where and when to plant

Scientists at Samara State University have developed the Electronic Agronomist software package. With its help, everyone - from farmers to officials of regional ministry of agriculture - will be able to get a forecast for the crop, as well as advice on where and when it is best to sow in order to fill the bins.



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The invented program is based on geo-information technologies of precision farming and Earth remote sensing data - images from space.

Samara scientists have been conducting research in this area for more than a year, this agricultural complex is constantly developing and receiving new options.

"Thanks to him, Samara agronomists and employees of the Ministry of Agriculture already have a complete current picture of crops," said Andrei Chernov, one of the developers of the system, associate professor of the Department of Geoinformatics and Information Security of Samara State University. - Now we have added an option such as yield forecasting to the system, and we are planning crop rotation.

"Electronic agronomist" will tell you what, in what order, at what time and in what amounts to sow. When and what fertilizers to apply to get an increase in the crop. Well,

during and after the harvest, the system also analyzes the data on the harvest. The area of crops simultaneously "scanned" from space is from one hundred to one million hectares.

To forecast yield for a separate field, the complex estimates the types of crops from the Earth's orbit in dynamics. Plus it analyzes the temperature, humidity and precipitation indicators, the current state of the soil and even the terrain.

Moreover, "Electronic Agronomist" "recalls" the types and quality of crops in this field in previous years.

- From space, you can see how crops are developing, what kind of vegetation index they have, showing the amount of photosynthetically active biomass. Along with meteorological data, the biological potential of seeds, the variety of plants, soil quality and many other factors are taken into account, - said Andrey Chernov.

*The area at the same time "scanned" from space crops - from one hundred to one million hectares*

Farmers will be able to interact with their "Electronic Agronomist" on the Internet through a web service or a special mobile application. Moreover, and this is very important, anyone can use this system - from a farmer to a large agricultural holding.

According to the developers, there are currently no similar programs on the Russian agricultural market. Therefore, the potential market capacity can reach up to four billion rubles a year with a total area of analyzed crops of 80 million hectares.

## **5. SCIENTISTS HAVE FOUND OUT WHAT MICROBES LIVE IN THE MOSCOW METRO**

Russian scientists from ITMO University, together with their American counterparts, conducted the first genetic study of the Moscow Metro microbiota. The results are [published](#) in the Computational and Structural Biotechnology Journal.

The study was conducted as part of the international project MetaSUB, which studies the composition of the microbial communities of urban spaces - metro, street, public places and transport.



Throughout their existence, people live surrounded by microbes - in addition to human microbes, bacteria are in the air, in soil, in water, in our homes. Some external microorganisms can harm human health, while others, on the contrary, are important for the development of the immune system. With the development of megacities, the composition of the surrounding microbiota began to change, and the intensity of contacts with them also changed. Scientists from different countries, united in the MetaSUB project, decided to find out what the microbiota of such an important transport system as the underground looks like. Researchers began from the subway of one of the largest cities in the world - New York, and now it has come to Moscow.

The traditional method of studying microbiota living on one or another surface is cultivation. The essence of the method is that the scientist takes a swab from the floor, wall or handrail, and then grows the bacteria in the laboratory so that it is easier to study. However, this method has a significant drawback: not knowing what bacteria are collected, it is difficult for scientists to choose a suitable environment for them, and some microbes cannot be cultured at all.

MetaSUB uses high-throughput DNA sequencing to comprehensively determine the composition of a microbiome. This method was used in the New York subway, and then in other transport systems, including in Moscow.

“Scientists have studied the surface of the floor, handrails, wagons and found an interesting variety of microbiota,” the words of one of the authors of the study, Alexander Tyakhta, an employee of ITMO Computer Technologies Laboratory, are

quoted in the university's press release. The purpose of this work is to describe the diversity, find general environmental patterns of such microbial communities, and create the basis for a more targeted analysis of microorganisms living in public places. "

Scientists compared the results obtained in Moscow with the results of American studies and found that the most common bacteria in the Moscow and New York metro are the same.

"The most represented bacterial species in Moscow are Dietzia, Brevundimonas, Pseudomonas, Arsenicococcus, Stenotrophomonas," says bioinformatist Natalya Klimenko. corners of the world - the same patterns of composition of microbial communities. "

Another observation was that the diversity of bacteria at specific stations correlates with the amount of passenger traffic. Moreover, in places where there are more bacteria of soil origin, biodiversity is maximum, and in those where skin microbiota predominates, it is lower.

It is noteworthy that, during the analysis, pathogens were not detected - out of 10 pathogenic bacteria, the DNA of which the method used could identify, not one was reliably found. Nevertheless, scientists emphasize, this does not mean that hands after the escalator handrail can not be washed. The study was not aimed at detecting pathogenic microbes, and the applied method of analysis is not sensitive to viruses, fungi and protozoa.

Although this study is only a pilot project, it showed that DNA sequencing can be successfully used to study the microbiota of public spaces. Scientists note that it will be useful to conduct, together with specialists from the field of hygiene and epidemiology, a broader study of all stations and surface types of the Moscow metro, supplementing it with point microbiological methods.

## **6. RUSSIAN SCIENTISTS EXPLAIN WHY PREGNANT BRAINS DO NOT ADAPT WELL**

Russian biochemists have found that with a lack of oxygen in the brain of pregnant women, the exchange of amino acids is disrupted, which can affect the whole body. The results of the study are [published](#) in the journal Cells.





Every tenth pregnancy is complicated by insufficient supply of oxygen to the mother and fetus. Concomitant pathologies of embryo development are being actively studied, but until recently, little was known about the effect of this factor on the mother's body.

To understand how a woman's sensitivity to oxygen deficiency can be reduced, Russian scientists from Moscow State University examined and described the cellular processes in the brain of pregnant rats and found that amino acids play a key role in these processes. The research is supported by the Russian Science Foundation (RSF).

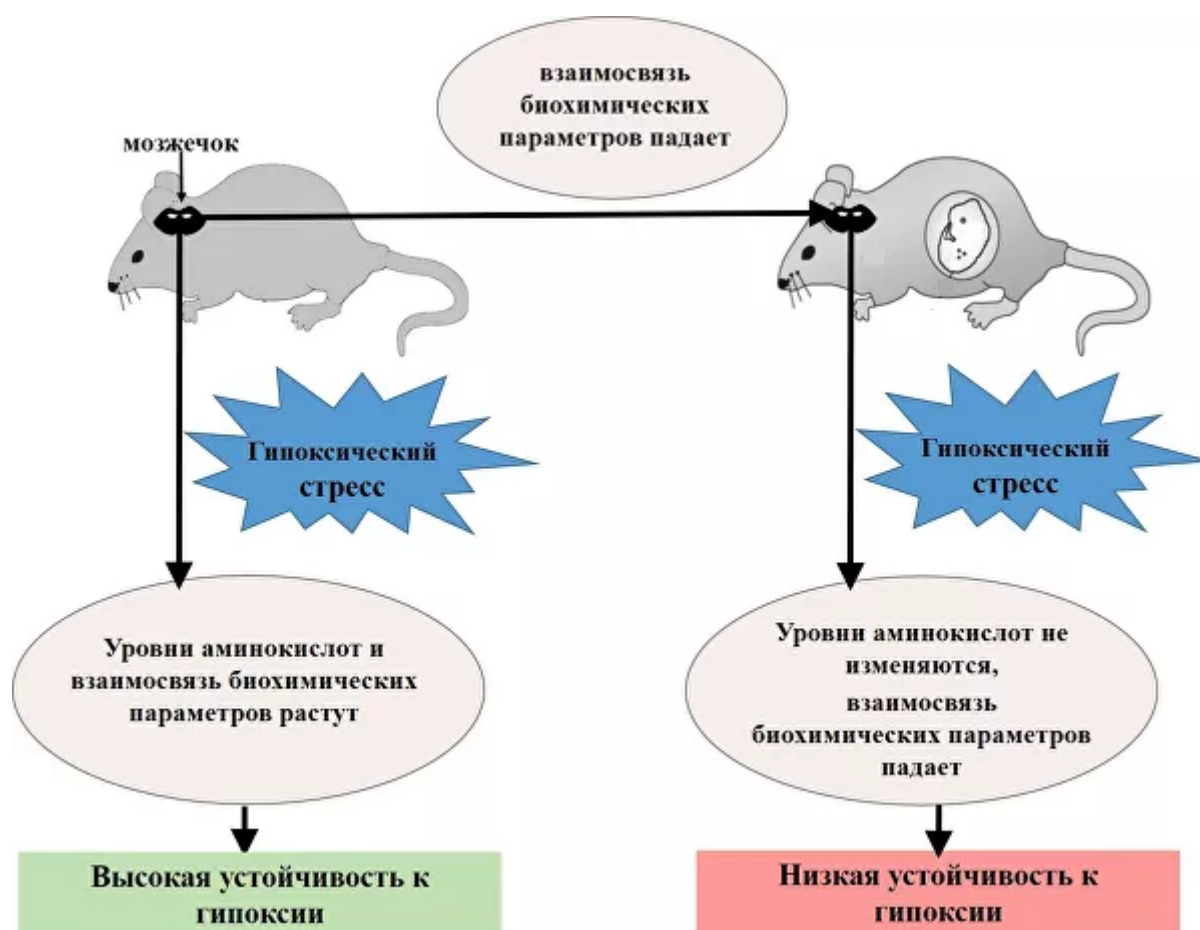
The brain is a complex natural object in which amino acids - the constituent parts of proteins, and their derivatives - serve to transmit and regulate complex signals. Even small changes in the level of these substances in the brain can affect the entire body.

For example, when a danger arises, certain protective mechanisms must be triggered, however, a lack of amino acids that "turn on" these systems can lead to an inadequate reaction and even death of the body. It is also known that changes in levels and impaired conversions of amino acids in the brain lead to neurological disorders, since these molecules serve to transmit signals between brain cells.

Scientists have developed an approach to measure the content of amino acids in the brain and describe their involvement in different cellular processes. They studied how the levels of these substances change in 17 pregnant and 25 non-pregnant rats after they were placed in a pressure chamber, where the oxygen concentration was reduced from the usual 21 percent to 5 percent. The resistance of rats to a lack of oxygen was

determined by the time during which the animals could be in such conditions without losing consciousness.

Researchers then analyzed rat brain cells for amino acid content and composition. To do this, they divided the amino acids among themselves, staining them with special dyes, and determined the concentration of each molecule in the studied solutions.



It turned out that with a lack of oxygen in non-pregnant rats, the level of 7 out of 15 amino acids in the brain increased. This was the reaction of the body to changing conditions. However, in the brain of pregnant rats, their content remained unchanged. Therefore, such rats did not adapt well to changing conditions and could not last long in a chamber with a low oxygen

“In previous studies, we showed that the content and conversion of amino acids in the brain of rats is closely related to their content in the blood. Therefore, to move from

the study of animal brains to medicine, you can study the corresponding biochemical parameters in the blood of people. Such projects will help the development of personalized medicine and will be significant for a wide range of pathological effects, "the research leader Victoria Bunik, a leading research fellow at the Research Center, quoted in the press release of the Russian Science Foundation Institute of Physical and Chemical Biology named after A. N. Belozersky, professor at the Faculty of Bioengineering and Bioinformatics, Moscow State University M. V. Lomonosov and professor of Medical University. I.M.Sechenova.

## **7. PERMAFROST WILL MAKE A QUARTER OF THE TERRITORY OF RUSSIA SUITABLE FOR AGRICULTURE**

Thawing of permafrost, as well as an increase in average annual temperatures, will make approximately 4.2 and 4.3 million km<sup>2</sup> of the territory of Canada and Russia suitable for growing wheat, potatoes and a number of other frost-resistant crops. Scientists write about this, an article published by the scientific journal [PLOS ONE](#).

"It's important to understand that the exploitation of these new lands can greatly affect the climate and ecology of the entire planet. Over 177 billion tons of carbon is stored in their soils, which is comparable to the amount of CO<sub>2</sub> emissions that the United States can produce in a hundred years. In addition, there are the most important watersheds on which the lives of over 1.8 billion people depend, "the researchers write.

Almost all climatologists today have no doubt that global warming exists and that it will radically change the face of the planet if temperature growth cannot be kept at 1.5°C. This is evidenced not only by hundreds of computer models of the planet's climate, but also by thousands of measurements made using various climate satellites, land meteorological stations and ocean buoys.

The first and main victims of this process will be, as practice already shows, the polar regions of the Earth and mountain glaciers. The temperature in their territory has now become 4-9 °C higher than in past centuries. Already this can irreversibly reduce their area and free large areas of Antarctica and the Arctic from ice.



On the other hand, the warming of the Arctic can make life easier for people, making local winters less cold, and soils accessible for agriculture. All this can make the “uninhabited” regions of Eastern Siberia, the Far East, Alaska and the Canadian Arctic more attractive to humans than the southern regions of the Earth, where heat and drought will often threaten his life.

### **New Territories**

Climatologists led by Arnaut van Susbergen, using detailed calculations, estimated which part of these "new inhabited territories" of the Arctic, freed from permafrost and harsh climate, would be suitable for agriculture.

To do this, scientists calculated how the temperature of the soil and air, as well as soil moisture and two dozen other climatic parameters important for the cultivation of cereals and other crops will change in the next few decades.

Based on the results of these calculations, van Susbergen and his team assessed whether representatives of a dozen key agricultural crops can grow in such conditions, starting from the oil palm and ending with millet.

It turned out that global warming will make vast areas (about 15 million square kilometers) suitable for cultivating at least four frost-resistant crops: wheat, soybeans, corn and potatoes. In the event that the Paris Agreements are fully implemented, the area of these lands will be somewhat reduced, but the general outlines of these territories will be the same.

About half of this growth will come from Russia and Canada, whose residents will be able to expand their land by about four million square kilometers. Less significant areas will become suitable for farming in mountainous regions in the western United States, as well as in parts of Africa and Australia.

On the one hand, the exploitation of these new lands, scientists say, will help provide the world's growing population with food and other critical resources. On the other hand, they emphasize, their improper development can lead to the release of huge quantities of greenhouse gases, which are now sealed in the reserves of organic matter inside the permafrost, as well as to sharp shifts in the nature of the course of the northern rivers and their general weakening. Therefore, they must be mastered very carefully, conclude van Susbergen and his colleagues.

## **8. THE RUSSIAN PROJECT FOR THE STUDY OF THE SUN HAS RISEN IN PRICE**

The production of two spacecraft under the Interheliosonde program for the study of the [Sun](#) will cost more than 20 billion rubles, Vladimir Kuznetsov, director of the Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, told RIA Novosti.

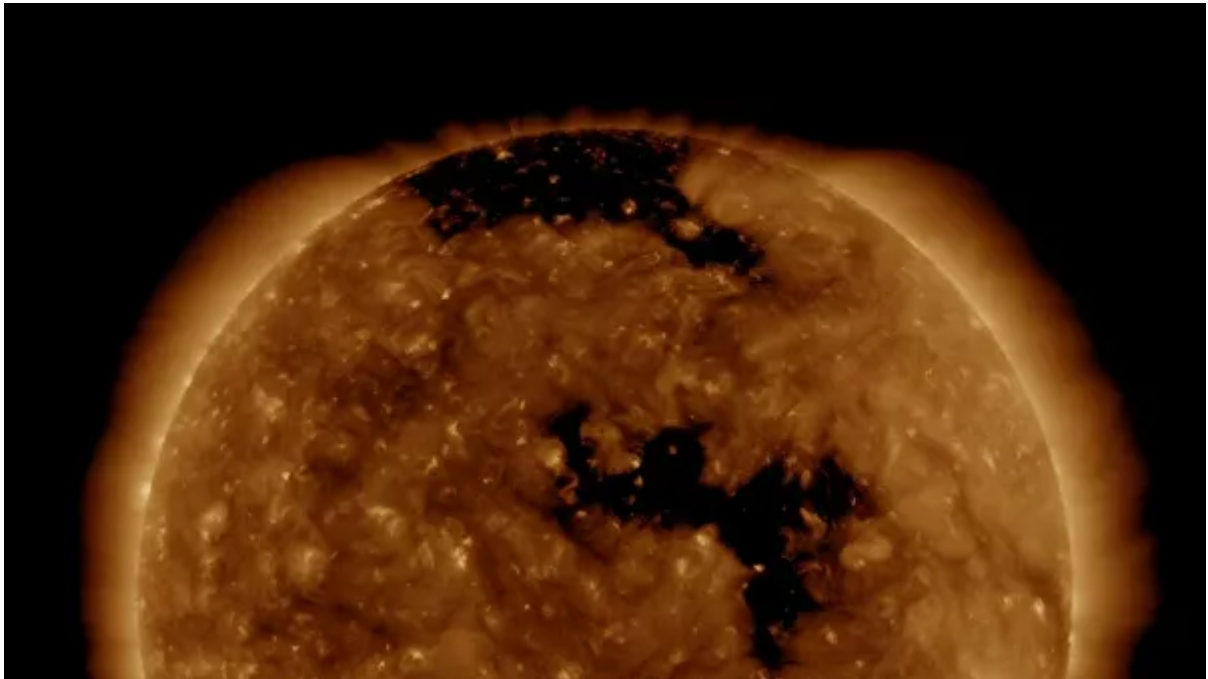
"It was originally planned that (for the implementation of the project) about 20 billion rubles are needed, but everything is getting more expensive. Now the amount has grown," he said.

Currently, Russia does not have its own satellites to study the sun. The last such device, "Coronas-Photon" ceased to work in 2009.

According to the current Federal Space Program, the launch of the first of the two Russian spacecraft of the Intergeliozond project was planned for 2025. Then it was transferred to 2026, but subsequently, due to underfunding, it went even further. So far, new launch dates have not been determined, RIA Novosti Kuznetsov said earlier.

The Interhelioprobe is a joint project of a number of Russian institutes and 13 European countries, designed to study solar-terrestrial relations. The two probes that are planned to be created as part of the project, performing multiple gravitational maneuvers near Venus, will gradually approach the Sun and take measurements along the Sun-Earth line along the way.





The mission will allow scientists to study the atmosphere of the Sun from close range and take measurements from outside the ecliptic plane in which the Earth's orbit is located. In particular, the devices will be able to "make out" the polar regions of the Sun, to study flares and other active processes.

"We were asked at one time to make projects that are unique, at the forefront of world science. The Intergeliozond is such a project. There are a lot of modern technologies, everything is new. European colleagues rate it as fantastic in terms of setting scientific tasks and its scale. It remains only one thing is to realize it, "Kuznetsov said.

## **9. ISS ASTRONAUTS WILL TEST A 3D PRINTER AND A COATING ON PORTHOLES DEVELOPED IN TOMSK**

Tomsk Polytechnic University (TPU) prepared a program of experiments at the International Space Station (ISS), coordinating it with RSC Energia. During the experiments, which will begin in 2020, scientists will send to the ISS a 3D printer of their own design, which prints products from composite materials, as well as a device that strengthens the station's portholes with nanocoating, director of the TPU Engineering School of New Production Technologies Alexei Yakovlev told TASS.

"We and RSC Energia agreed on all technical specifications, they approved the program (experiments). We received letters from RSC Energia to begin the contracting process. We were waiting for the coordination of the experiment program, funding will come from RSC Energia in 2020 this year, this money will be enough for experiments on the ISS," the source said, without specifying the amount of funding.

Yakovlev explained that the program approved three experiments to test the technology. The first is associated with the developed TPU 3D printer for products from composite materials in space. It will allow you to create particularly durable and at the same time lightweight instruments right on board the station. In the future, it is planned to expand the program and test the capabilities of 3D printing in outer space. The Peresvet experiment will also be conducted, in which a multilayer nanocomposite coating will be applied to the ISS portholes to protect glass from space debris and micrometeorites.

The third experiment involves the testing of nanosatellites - miniature spacecraft that can be launched into orbit by an astronaut who went into open space, just by releasing from his hands. In the future, such devices will work in a group, performing various tasks related, for example, to navigation and communication. In the future, satellites will even be able to repair each other in orbit.

"The project is carried out by Skoltech, we are one of the 15 participants. Our main task is 3D printing of the satellite bodies we specialize in. As part of this experiment, we will have to print ten satellites every year, the rest of the consortium will be engaged in their filling." - he added.

According to the scientist, in 2020 the university will begin experiments and, by the end of 2021, will manufacture mock-ups of equipment for printing, conduct tests on Earth, make adjustments to the design documentation, prepare a task for astronauts on new equipment, and also manufacture two devices for the experiment - one for testing in space, and the other for control on Earth. At the end of 2021, the equipment will go to the space station.

## **10. SCIENTISTS EXPECT THAT SINCE 2022, PIONEER-M WILL BE ABLE TO GO TO SEA WITHOUT A CREW**

Scientists at Sevastopol State University are planning to equip the latest Pioneer-M research vessel with such equipment so that it can go out to sea and perform simple

operations without a crew, TSSU Vice-Rector for Development, Scientific and Innovative Activities Maxim Evstigneev told TASS.

"Crewlessness is the second phase of the project, not already associated with the Ministry of Education and Science. Tentatively, we will implement it in 2022-2023," Evstigneev said. It is assumed that the development of unmanned vessel technology will begin with simple operations - in particular, sampling sea water at a given point.

He explained that already at the stage of the ship's construction, system elements would be laid that would partially realize the ideas of crewless control. To fully realize this project, it will be necessary to retrofit the Pioneer-M. The total cost of modernization is estimated at 300 million rubles - about the same as the cost of building a ship.

"The creation of crewless vessels is one of the so-called markets of the future. Shipping in the future will be much more economical, more profitable, because human work will be reduced. At sea, the vast majority of operations at sea are routine: for example, shipping cargo from shore to a drilling platform, environmental monitoring coastal waters and other similar actions that can be performed by an unmanned vessel. Crewlessness will seriously save companies in the construction and operation of ships: after all, life support systems and of the safety of the people is very expensive, "- said vice-rector.

According to him, it will be possible to manage such vessels from the shore. The operator located in the control center will be able to track ship operations and, if necessary, adjust them.

### **About the Pioneer-M project**

The design of Pioneer-M was carried out by scientists at the Sevastopol State University at the base department, Innovative Shipbuilding and Shelf Development Technologies, created by the Coral Design and Design Bureau. The ship will be built at three plants of the United Shipbuilding Corporation (USC). The Sredne-Nevsky Shipyard will carry out work on the formation of the composite hull, the creation of the superstructure will be undertaken by the specialists of the Crimean enterprise Sudokompozit, the final assembly will take place at Sevmorzavod. The length of the vessel will be 25.7 meters, width - 9 meters, speed - 10 knots, displacement - 82 tons.

The project is implemented with the support of the Ministry of Education and Science of the Russian Federation, USC and the Agency for Strategic Initiatives. The construction is financed under the federal target program "Research and Development in Priority Directions for the Development of the Russian Science and Technology Complex for 2014-2020." The industrial partner is USC. Investments in the implementation of the project amount to 300 million rubles.

## **11. RESEARCHERS AT MIPT AND PRINCETON SIMULATED A HIGH-VOLTAGE DISCHARGE IN FRONT OF A SUPERSONIC AIRCRAFT**

Scientists from Russia and the United States simulated the appearance and behavior of a high-voltage discharge in front of a supersonic aircraft. The data obtained will help make flights of such airliners and spacecraft safer, TASS reports citing the press service of the Moscow Institute of Physics and Technology (MIPT). The results were published by the scientific journal [Plasma Sources Science and Technology](#).



Discharges occur in the Earth's atmosphere, which propagate from the surface of the earth to the ionosphere and in the opposite direction. At relatively low altitudes (up to 10 km), discharges propagate in the form of structures that lead to lightning. Such discharges can damage some devices of an airplane or a spaceship. 90% of lightning strikes in these objects are due to electrical breakdowns that the aircraft itself initiates.

Scientists from the Moscow Institute of Physics and Technology, together with colleagues from Princeton University, modeled the interaction of a high-voltage streamer discharge (streamers - filamentary electric discharges) with a shock wave, which is formed when the aircraft accelerates to a speed above sound. It turned out that when the difference in air densities on opposite sides of the wave exceeds 20%, the discharge cannot overcome it and begins to propagate along the wave itself in the form of a kind of plasma “pancake”. The data obtained will help to more accurately simulate the conditions around supersonic aircraft and spacecraft, the press service said.

The researchers considered other cases, for example, when the density of the gas changes smoothly, and also found the conditions when the gaseous medium ceases to conduct current in one direction or another for a short time. So, a gap in the density of the medium from a rarefied gas to a dense one forms a kind of gas-dynamic diode - a physical phenomenon when a gas discharge can develop in one direction and cannot in the opposite.

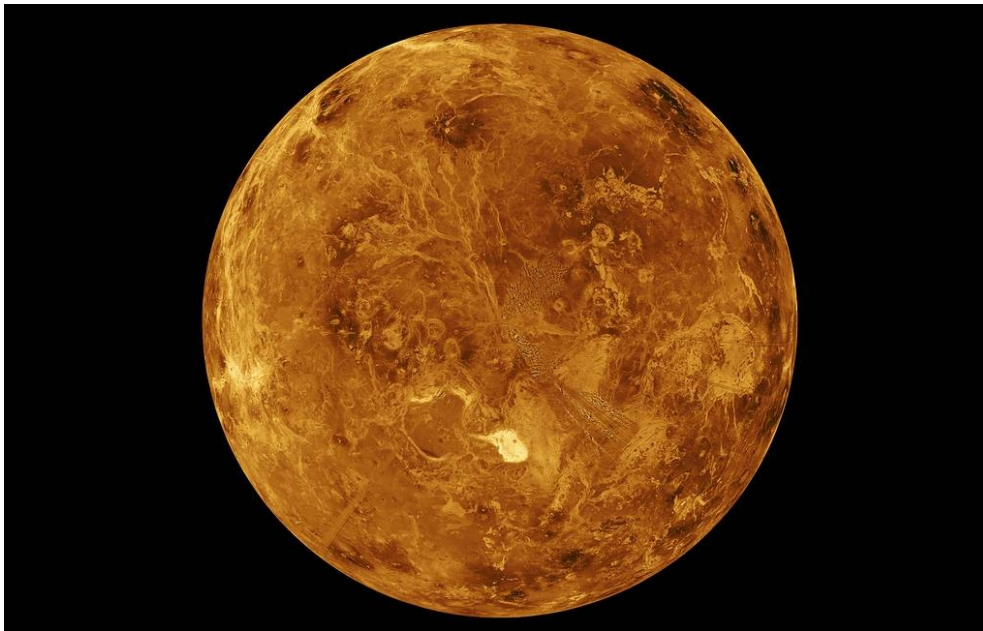
According to scientists, the results will allow better modeling of gas flow control processes around supersonic and hypersonic aircraft.

## **12. SCIENTISTS HAVE IDENTIFIED FIVE POSSIBLE LANDING SITES ON VENUS**

Specialists of the joint Russian-American working group for the Venera-D project identified five potential locations for landing the landing vehicle. Later, one of them will be selected in the region of the Northern Hemisphere of Venus, told reporters on Monday Lyudmila Zasova, head of the planetary spectroscopy laboratory of the Space Research Institute of the Russian Academy of Sciences (IKI), co-leader of the working group for this project.

“Five groups of specialists choose landing sites - each group has its own group. They will offer us these landing sites, and then we will choose which one suits us,” Zasova said. According to her, experts have chosen all five landing sites in the northern hemisphere of Venus, in high latitudes. “Venus rotates, but the orbit stands. We don’t have a satellite to somehow vary the orbit, so we need high latitudes,” she explained.





One of the tasks of the Venera-D mission will be to monitor the long-lived stations that will appear on this planet. "For example, American long-lived stations will operate from 60 to 120 days," said the head of the IKI RAS laboratory.

Scientific Leader of IKI RAS Lev Zeleny told reporters that the second topic that was discussed at the meetings of the working group is the cloud layer of Venus. "There is an opinion that there may be some kind of microorganic life. The scientific equipment that could register this was discussed," he said.

According to Zeleny, Russian and American specialists continue to work on this project and are awaiting the official decision of Roscosmos to open development work on Venus-D. "This mission should be realized in the next decade," the scientist added.

### **Project "Venus-D"**

Earlier, Zelyony informed TASS about the hopes of Russian scientists that Roscosmos would begin financing a preliminary design of the joint Russian-American program Venera-D in 2020. According to him, the preliminary design costs several hundred million rubles and can be ready in one and a half to two years after the start of financing.

According to a joint project, Russia will have to create a landing station (Venera-D, where "D" means "long-living"), and the United States should supplement the mission with various studies and, possibly, a small spacecraft.

It is planned that the device will continue to study Venus, that is, to study its structure, the dynamics of the lower atmosphere, volcanism and other processes. From the Russian side, the project is being carried out by IKI RAS and S.A. Lavochkina. The project should be implemented in collaboration with NASA; they plan to launch a mission in 2029.

Earlier, deputy director of IKI RAS Oleg Korablev said that the cost of development work under the Venera-D project would be approximately 17 billion rubles. According to the President of the Russian Academy of Sciences, Alexander Sergeyev, the cost of the mission can reach \$ 1 billion.

### **13. RUSSIAN SCIENTISTS CREATE QUANTUM MEMORY BASED ON MICROWAVE DEVICES**

Scientists of the Kazan quantum center of the Kazan National Research Technical University named after A.N. Tupolev (KNITU-KAI) are developing a system of devices that perform memory functions for quantum computers and communication systems. The created memory will be able to store up to 99.9% of data during storage and transmission, the director of the center, professor Sergey Moiseev, said on Wednesday.

Quantum computers capable of performing calculations that would have taken decades for a regular computer to perform require special memory, in which the system could work simultaneously with a large number of quantum bits (photon qubits) of information and ensure minimal loss during its storage and transfer. The process of writing and reading should have high-precision addressing, in which it would be possible to track the actions of each photon qubit. The authors of the study are working on the creation of such a quantum memory using waveguide-resonator technology for storing and transmitting data in the microwave frequency range - one of the promising areas for creating a multi-qubit quantum computer.

“We are developing memory for quantum computers that use superconducting qubits as processors and microwave photonic qubits as storage media. The basis of the memory architecture is microwave waveguides and high-Q resonators, which are connected to each other in a special way. It allows you to simultaneously achieve a broadband data channel and ensure high levels of information retention during its transfer. We expect that the result of our work will be the emergence of sufficient multi-

resonator quantum memory, which will allow to store for a long time 999 out of 1000 photon wave packets, on the quantum states of which information can be transmitted and processed in multi-qubit quantum computers, "the source said.

Scientists have created an experimental setup and tested it at room temperature. The indicator of the so-called quantum efficiency, determined by the ability of the resonators to retain vibrations for a long time (quality factor), was 16.5%. To increase it, the researchers plan to adapt the elements of the system to work at low temperatures (about 273 degrees below zero).

"Over the next year, we intend to test the system of waveguides and resonators at low temperatures. Such conditions are needed to increase the quality factor of the used resonators by a thousand times or even more, and, accordingly, to ensure the ability to store photonic qubits in a quantum memory cell without destruction and with very high accuracy. Today it is obvious that the memory architecture, based on a system of high-quality resonators, will be able to work like that, "the scientist concluded.

The scientific work is supported by grants from the Russian Foundation for Basic Research and the Russian Science Foundation.

#### **14. SCIENTISTS HAVE DISCOVERED AN UNKNOWN FORM OF CARBON IN THE CHELYABINSK METEORITE**

Scientists have discovered an unknown form of carbon on Earth in fragments of a meteorite that [fell in the Chelyabinsk region](#) in 2013, told RIA Novosti associate professor of theoretical physics at Chelyabinsk State University, Sergei Zamozdra.

He said that the dean of the Faculty of Physics Sergey Taskaev (now the rector of the university. - Ed.), While studying samples of meteorite dust, noticed something brilliant.

"At first he thought it was a diamond, because there were six faces. Later in Germany, this crystal was pulled out with micro-tweezers and X-rayed — it turned out to be not a diamond, but a carbon crystal. We measured the position of atoms, the planes of interatomic, then Korean specialists on a computer calculated that, indeed, such an arrangement of atoms is possible, "the source said.



According to him, carbon can have many modifications, including this one. This is called a multiple twin crystal, he specified, adding that now scientists are preparing publications on this topic.

Such carbon has not yet been found on Earth, and experts will have to figure out how it came about, calculating different options.

“One option is that this arose in space conditions, because it is a billions of years of a process. Or already when flying in the Earth’s atmosphere. Sergey Taskaev also adheres to the second hypothesis,” he said.

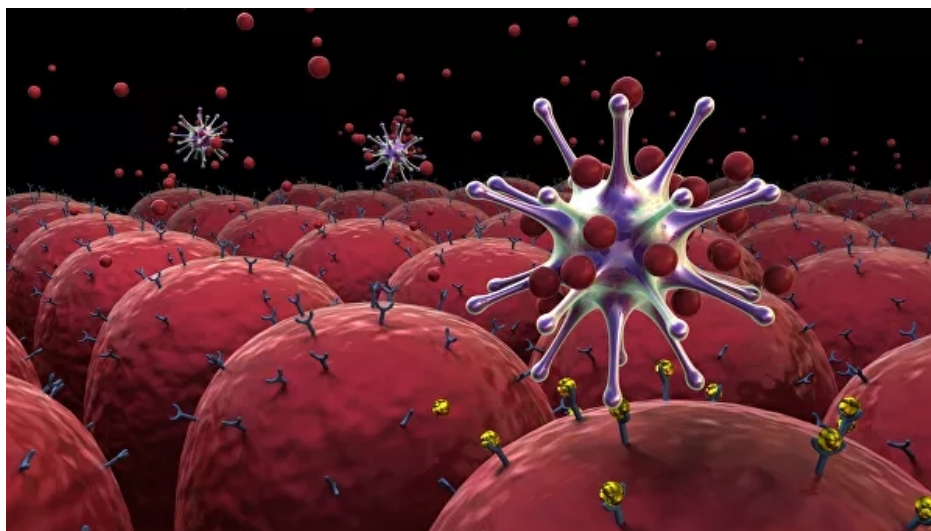
According to the press service of Chelyabinsk State University, the study of meteorite fragments was carried out by Sergey Taskaev together with colleagues from the Technical University of Darmstadt (Germany) and the National University of Kengpuk (Republic of Korea).

In the Chelyabinsk region on February 15, 2013, thousands of people watched a very bright car in the sky. In the first minutes, the expansion and twisting of its smoky plume was visible, followed by an air wave strike, similar to the sound of a strong explosion.

Fragments of the meteorite were found in the vicinity of Chebarkul, but the largest - more than 600 kilograms - was raised from the lake of the same name. Now it is stored

in Chelyabinsk in the South Ural State Historical Museum under a special dome in the exhibition hall, everyone can see it.

## **15. SCIENTISTS HAVE FIGURED OUT HOW TO PROTECT THE BODY FROM ALL VIRUSES AT ONCE**



Scientists have discovered a new potential target for antiviral drugs. The discovery may lead to the creation of a universal method of treatment immediately for many infectious diseases. The results of the study are [published](#) in the journal Cell Reports.

As the outbreak of coronavirus in China shows, viruses are a constant threat to humanity. Vaccines are regularly developed and introduced against some of them, but this process takes a lot of time, helps not everyone, and does not protect against new viruses.

Scientists from the Massachusetts General Hospital (USA), in collaboration with colleagues from the German Cancer Research Center in Heidelberg, discovered the Achilles heel of most viruses - the AGO4 protein.

AGO4 is one of the proteins of the Argonaute family. Until now, his role has not been fully understood. Now, researchers have found that this protein has a unique antiviral effect in somatic mammalian cells.

The authors of the study studied the antiviral effects of several Argonaute proteins in mice and found that only AGO4-deficient cells were hypersensitive to various viral



infections, including influenza. In other words, low levels of AGO4 increased the likelihood of infection of mammalian cells. From here, the researchers concluded that increasing the level of this protein can help strengthen the immune system and defend against many viruses.

“The goal is to understand how our immune system works in order to create treatments that work against a range of viruses, not just vaccines against a specific one,” said Kate Jeffrey, head of the study, in a hospital press release ( Kate Jeffrey).

Mammals, like many other animals and plants, have four Argonaute proteins (1-4), which act by suppressing genes. Argonaute is involved in the formation and regulation of RNA and miRNA activity, that is, it acts as an effector protein of RNA, and RNA interference is the most important antiviral defense strategy for cells.

Scientists plan to continue research.

“The next step is to determine how wide the spectrum of action of this protein is for any type of virus,” says Jeffrey. “And then we need to figure out how to increase the activity of AGO4 to enhance protection against viral infections.”

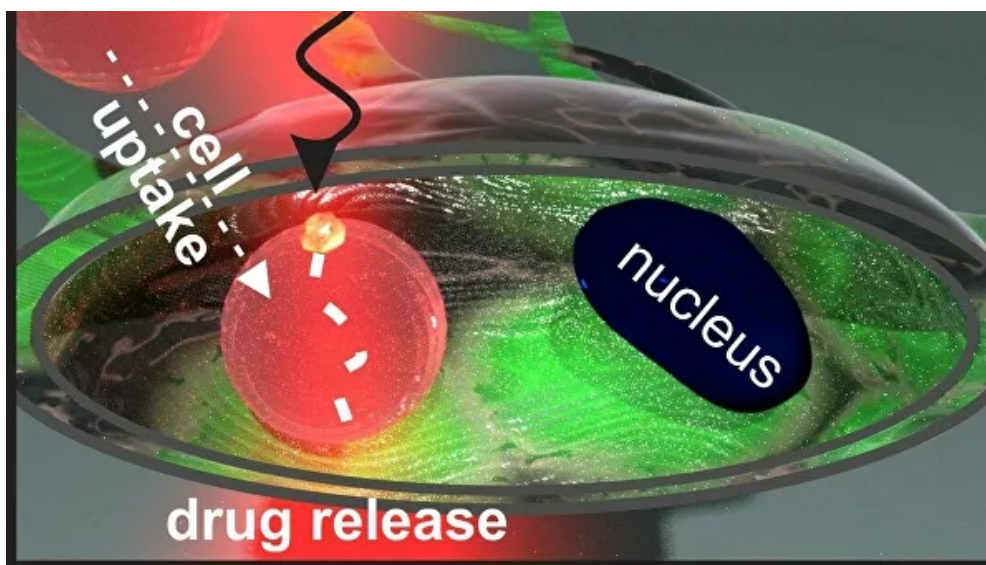
## **16. RUSSIAN SCIENTISTS HAVE DEVELOPED A METHOD TO FIGHT CANCER WITH RUST**

Scientists have found a way to non-invasively release drugs inside cancer cells. This is another step towards creating a targeted delivery system for anti-cancer drugs. The results of the study are [published](#) in the journal Laser and Photonics Reviews.

Currently, there are drugs that can fight malignant neoplasms, but for their effective work, new approaches are needed for targeted delivery of drugs directly to cancer cells, leaving healthy cells intact. One of these approaches is the delivery of drugs using micro- and nanoparticles, in which locally high concentrations of the drug are created in the tumor area with minimal systemic concentrations throughout the body.

Resonant semiconductor nanoparticles of iron oxide - the very one that familiar rust consists of - can locally heat up under the influence of a laser and convert the resulting light into heat. If such particles are included in the shell of polymer container capsules

to deliver bioactive substances to cells, then it will be possible to remotely heat them and control the release of drugs in the right place and at the right time.



Russian scientists in collaboration with French and Chinese colleagues managed to develop such capsules, distributing among themselves the roles in the project. Scientists of ITMO University were responsible for the synthesis and optical characteristics of iron oxide nanoparticles - the task of our scientists was to make carrier particles photosensitive. French colleagues made a complete description of the entire spectrum of structures of semiconductor nanoparticles. Colleagues from China visualized the process of opening the capsules with the medicine, and employees of the First Medical University of St. Petersburg conducted biological experiments to deliver the antitumor drug to the primary tumor cells.

"We tested our systems for delivering vitro drugs on stem and tumor cells. The stem cells in this experiment were used as a model of healthy cells, and the tumor cells as a model of diseased cells. As a control, the cells were simply irradiated with a laser with the same parameters. As a result, the action of the antitumor drug was directed against tumor cells when they were irradiated with a laser, while the toxicity of drugs was practically not observed with respect to healthy cells. An efficient light-sensitive systems for drug delivery into cells, "- presented in a press release the University ITMO words Zyuzin Michael, one of the study's authors.

The advantage of iron oxide is that this material is not only an effective nanowater, but also a local nanothermometer. That is, when particles are irradiated, the temperature can be controlled, thereby preventing overheating of healthy cells and tissues.

"Nanoparticles in this case act as converters of light into heat and at the same time as a thermometer. The fact is that it is extremely difficult to measure the temperature by traditional methods on such small objects. For example, there are different methods that use dyes that burn out and stop when a certain temperature is reached. But the problem is that it is not reusable thermometry, and it is binary, that is, we can only understand: is it higher than a certain temperature or lower - yes or no. There will be no concrete indicators there. And semiconductor nanoparticles effectively absorb light and convert it into heat. Because of this, the vibration frequency of the crystal lattice begins to change a little and the light begins to scatter differently. From these changes we can determine how much we heated the particle,

Researchers intend to continue to work and improve the results. Preclinical studies in laboratory animals are planned for next year.

## **17. PHOTONIC INTEGRATED CIRCUITS (FIS)**



A young physicist from Perm State National Research University (PSNIU) has developed a data library for the design of photonic integrated circuits (FIS). This will halve the process of creating modern tomographs, and will also help in the manufacture of gas

concentration sensors for environmental monitoring systems, the press service of the Russian Ministry of Education and Science said on Tuesday.

FIS - a device that contains many optically interconnected components (waveguide connections, power dividers, amplifiers, modulators, lasers and detectors). They are made on the same substrate and together perform a variety of optical signal processing functions.

"Dmitry Moskalev, Master of Physics at the PSIU, optimized the production of photonic integrated circuits, learning how to create libraries of materials and technological processes for their design. This will, for example, halve the process of creating modern tomographs <...> Based on the developed database, besides tomographs, it's possible production of gas concentration sensors for environmental monitoring systems, as well as a system - an X-ray analogue for transparent materials, "the report said.

Photonic circuits are created in three stages: modeling individual components, adding individual components into a chip (integrated circuit), and manufacturing a chip in a factory. Using the Perm scientist's library will allow you to skip the first stage of creating FIS due to the fact that it already includes the basic building blocks and the rules for their layout. Developers will only have to select the necessary base units, form a chip on their basis and transfer it to the factory for production.

The database was developed for circuits based on silicon nitride ( $\text{Si}_3\text{N}_4$ ) - a transparent crystal that supports the propagation of light. Photonic schemes based on it allow you to create sensors, process optical signals or encrypt them in quantum cryptography tasks.

The developed FIS library is currently being tested at the National Center for Microelectronics in Barcelona (IBM-CNM). After checking the results on real schemes, it is planned to introduce development in domestic production. The study was conducted as part of an academic exchange of students between Perm University and the Polytechnic University of Valencia (University Politecnica de Valencia, Spain).

## **18. THE DIAMOND MATERIAL IS UNDER OUR FEET**

Siberian geologists for the first time experimentally proved that in diamonds growing in the bowels of the earth, there may be material from the surface, which falls to great

depths during tectonic shifts. An article about this was published in the journal of the first quartile of Gondwana Research.

As we know, diamond is formed from graphite. However, it rarely happens that this process takes place directly, since extreme parameters are needed: pressure is greater than 15 gigapascals and temperatures are higher than 1,500 ° C, which are characteristic of great depths in the thickness of our planet. More often, diamonds prefer to grow under moderate conditions, 150-200 kilometers underground at a pressure of 5-7 gigapascals, and they use the help of intermediaries - melts, which serve as catalysts and allow the reaction to proceed at lower pressures and temperatures. Schematically, the process can be represented as follows: first, graphite dissolves in the melt, forming carbon complexes in it, and only then diamond is formed from carbon.

Synthetic diamonds are grown in laboratories and factories by placing graphite in transition metal melts (iron, nickel, cobalt, manganese). It used to be that in nature, diamonds form in them. Recently, some crystals have indeed found inclusions of solidified metal melt. However, we are talking only about exceptional diamonds that formed at much deeper depths than usual - in the transition zone or lower mantle of the Earth. Such crystals include, for example, the world's largest natural diamond of jewelry quality "Cullinan", or "Star of Africa" (weighed 621.35 grams before it was split into several parts).

In most diamonds, inclusions of other melts are found, primarily highly alkaline carbonate and silicate. Since the Israeli chemist Oded Navon discovered them in 1988, many laboratories around the world have continued a detailed study of these substances. Institute of Geology and Mineralogy. V. S. Sobolev SB RAS has been working in this area for many years. In the late 1990s, it was shown here that diamonds can grow in alkaline carbonate melts in the same way as in metallic melts, but at much lower temperatures, almost like in nature. Now Siberian geologists have shed light on another important question: how do high-alkaline carbonates and silicates get to where diamonds grow.

The fact is that alkalis, primarily potassium, which are contained in melt inclusions of diamonds, are not characteristic of the depths at which these diamonds grow. Among scientists, the prevailing point of view is that alkaline compounds enter there from the Earth's surface as a result of the movement of lithospheric plates (large areas of the

earth's crust). There is enough alkali in the continental crust: it is rich in granite, and this is a high-potassium rock.

Material from the continents is continuously washed off into the ocean during rains, melting glaciers, with river flows and accumulates at its bottom (these sedimentary rocks are called pelits). Oceanic plates slowly plunge beneath the continents and inevitably capture pelites with them.

As a result of tectonic movements to the mantle depths, the continent itself may also leave. One of the most famous geological evidence of this is the Kokchetav massif in Kazakhstan. They found unique rocks, which are layered material of the continental crust, they contain almost everything that is on the surface of the continent, including sedimentary formations, processed granite material and a very large amount of carbonates, and bear traces of high pressures and temperatures. This allowed scientists to conclude that the material sank underground, and then again rose to the surface. In some rocks of the Kokchetav massif, in particular in high-carbonate, contains a large number of small diamonds.

A similar breed complex is in Germany near Dresden, it is called Erzgebirge. There, in the composition of garnets, high-potassium silicate and carbonate melts, as well as small diamond crystals, were also found. "The existence of the Kokchetav massif and Erzgebirge is evidence that melt inclusions in diamonds could appear as a result of melting of the material of the continental crust rich in potassium and carbonates," says a leading researcher at the IGM SB RAS, head of the laboratory of phase transformations and phase diagrams of the Earth's matter at high pressures, doctor of geological and mineralogical sciences Anton Farisovich Shatsky.

Scientists from the IGM SB RAS decided to experimentally check whether melts found in diamonds actually form from these rocks at great depths. They prepared a composition corresponding to the average composition of the continental crust, added carbon dioxide in the form of carbonates and placed it in a Discoverer 1500 press at a pressure of 6 gigapascals, which corresponds to a depth of about 200 km, where most natural diamonds grow. The temperature in the experiments ranged from 1,000 to 1,500 degrees, so scientists covered the entire temperature range at which natural diamond formation is assumed. Then the samples were removed from the press, a section was made and examined under an electron microscope and more subtle methods using Raman spectroscopy.



“When we analyzed the composition of the samples, we found that it was close to the compositions of the mineral melt inclusions of natural diamonds. At temperatures of 1,000–1,500 degrees, silica and other silicate minerals are formed in them, characteristic of one of the most common rocks in the mantle – eclogites. Similar associations are found in the Kokchetav massif, where they coexist with diamonds. Also, two high-potassium melts are present in the samples: carbonate and silicate liquids. Our data for the first time confirmed that they can be formed as a result of melting of continental material, which plunged to great depths, ”says Anton Shatsky.

## **19. “PHOENIX-2”: TOMSK SCIENTISTS HAVE CREATED A DEVICE FOR TREATING BONE CANCER**

A unique device for the treatment of cancer of soft tissues and bones was developed by Tomsk scientists. When using Phoenix-2, the dose of a chemotherapy drug is reduced by 2 times, inhibition of metastasis growth is increased by 3 times, and remission is 2 times longer. At the same time, bone strength is preserved, there is no threat of fractures.

The device is already being used at the Tomsk Scientific Research Institute of Oncology, 10 patients received treatment. There are positive results: in a 58-year-old patient, for example, a tumor in the left humerus has been completely absent for 7 months. The device acts on the tumor by heating, the principle of its action is this: direct current circulates through the heater without passing through the patient, which is affected only by heat waves.

“Phoenix-2” provides heating of the tumor at any depth and in strictly limited areas, suppressing its focus and metastases. When exposed to soft tissues, heating at + 45-46 ° C (hyperthermia) is used, and the patient can undergo outpatient treatment. In the treatment of bone cancer, a temperature of + 60 ° C and above (thermal ablation) is required, in which case the exposure occurs during surgery.

“Now in the treatment of bone tumors, either the bone is cut off and a prosthesis is placed, or a piece of bone is cut off, autoclaved [approx. ed.- heats up in a container with high temperature and high pressure] and connects to live bone, ”explained Denis Pakhmurin, associate professor of TUSUR, director of PromEI LLC, who collaborates

with scientists from the TSU medical materials laboratory.- Literally before the New Year, there was an operation at the Oncology Research Institute, the area of impact was 22 cm. If it is cut, autoclaved and put back, it means that almost all the bone is removed. Our method allows, without removing the bone, to effect during surgery on the patient. All the anatomical structures are preserved, subsequent regeneration processes should take place more simply. ”

Scientists from the TSU medical materials laboratory help the authors of the project determine how the use of the new device affects the strength characteristics of the bone.

“A normal bone is strong, it has structures that can withstand a large load, form a certain flexibility. If there is a tumor, a certain defect in the tissue - cavity appears, and accordingly, the strength of the bone is weakened. We were interested in if we are still healing up, whether there will still be bone weakening, ”explained Sergey Kulkov, head of the laboratory of medical materials at TSU, professor at the Institute of Physics and Mathematics SB RAS. “If you just remove the tumor, leave the cavity and not use our method, then maybe the patient will have less frequent fractures than if we act.”

TSU scientists have already conducted a series of experiments on animal bones, and the first results are encouraging: “Phoenix-2” does not adversely affect bone strength. Experiments to study the effect of the device on the mechanical properties of bones.

## **20. SKOLKOVO RESIDENT SUCCESSFULLY TESTED THE BLOCKCHAIN ON THE ELBRUS PLATFORM**

The Russian developer of B41 Blockchain Development, a resident of the Skolkovo Foundation’s Information Technology Cluster, developed and successfully tested the blockchain node assembled on the Elbrus hardware and software platform.

The Elbrus hardware platform was developed in Russia and is resistant to popular cyber attacks, including Meltdown and a number of Specter variants. This is of particular value to any digital field, and especially to the sphere of finance, where hacker attacks can cause serious damage. The reliability of the blockchain and the power of attorney of the equipment open the prospect for the next stage of import substitution and digitalization of the sectors of the national economy based on equipment and software exclusively made in Russia.

“The node is compiled in binary codes of the Elbrus processor and works stably. This is the first major success. Ahead are blockchain performance tests based on Elbrus and its optimization. In the future, we plan to integrate our Nodes Plus blockchain framework with Elbrus to digitalize priority industries, including fintech, banking, the Internet of things, industry, logistics and so on,” said Oleg Sivakov, chief developer of B41 Blockchain Development.

“The demand for solutions related to distributed ledger technology and cybersecurity has been growing steadily in recent years. The interest of business and the state is associated with the global digitalization of processes in all sectors, the active actions of regulators and the increased activity of hackers. The decision of the Skolkovo company B41 Blockchain Development, for example, can be called for to build a secure infrastructure of the quick payment system, which was launched this year at the initiative of the Bank of Russia,” said Pavel Novikov, director of the Skolkovo Foundation’s Finance & Blockchain Innovation Center.

## 21. SAMARA SCIENTISTS HAVE DEVELOPED A COMPLEX FOR BRAIN RESEARCH



According to the press service of Samara University, the OpenNFT.org software platform is designed to conduct research related to the formation of neurobiological feedback, and works on the basis of an MRI scanner.

During the experiments, the person in the scanner receives any information, for example, he sees images, hears sounds. At this time, scientists using Samara development every second receive and analyze scans of the activity of his brain with a

spatial resolution of 1 millimeter. The software complex compares which areas of the brain react to a particular stimulus, how they interact with each other.

The software package was developed jointly with specialists from the Institute of Image Processing Systems of the Russian Academy of Sciences, Yale University from the USA, Imperial College London, Lausanne Polytechnic School and the University of Zurich in Switzerland. Now the complex has been tested and is used in a number of well-known universities and research centers of the world.

We can understand how a person perceives this or that image, how he controls his emotions. The development allows you to solve a huge number of problems, including neurorehabilitation of people after a stroke. This is the only open such platform in the world. It is free and extensible, which allows research teams to freely adapt it to their goals, write the necessary plugins for it. The platform works on all types of modern MRI scanners, "said **Artem Nikonorov**, professor at the Department of Supercomputers and General Informatics at Samara University.

The platform is already successfully used in research projects of world scientific centers in Switzerland, USA, Great Britain, Germany, Spain. For example, in Switzerland, the Samara development is involved in the laboratory of neuroeconomics - this is an interdisciplinary area at the intersection of economic theory, neurobiology and psychology, studying the decision-MAKING process when choosing alternative options, risk allocation and reward.

## **22. PLASMA AND FUSION RESEARCH. THE DEVELOPMENT OF NOVOSIBIRSK SCIENTISTS WILL HELP CREATE A NUCLEAR FUSION REACTOR**

As part of the Russian Science Foundation grant, employees of several Russian institutes developed and published the concept of a nuclear fusion reactor that uses plasma as a source of neutrons. It is very difficult to obtain and retain plasma; its temperature should be above 100 million ° C.

Thanks to this solution, it becomes possible to use thorium as a fuel for the reactor, which is easier to control and easier to obtain from raw materials than uranium. In 2017, employees of the Institute of Nuclear Physics of the SB RAS presented the Smol installation, which demonstrates the technology of plasma creation and retention.



Together with the RFNC-VNIITF, located in the closed city of Snezhinsk and Tomsk Polytechnic University, INP scientists published the concept of a nuclear fusion reactor in the international journal *Plasma and Fusion Research*. This invention can be considered a step towards controlled thermonuclear fusion. "According to calculations, the installation should be able to withstand 3,000 days at a capacity of 100%. After this period, the blocks with burned-out fuel are replaced with new ones," writes the official publication of SB RAS "Science in Siberia". According to the publication, scientists plan to create an experimental stand at the TPU reactor site. If a hybrid reactor can be built, it could become a safer and more compact alternative to existing nuclear reactors.

### **23. SCIENTISTS HAVE DISCOVERED A NUCLEOTIDE THAT CAN PROTECT THE BODY FROM OXYGEN STARVATION**

What happens in the human body with the development of a particular ailment? The patient himself feels, first of all, the painful symptoms of the disease, such as a cough with bronchitis, but does not realize that in addition to this, in his organs and tissues at the intracellular level, the usual course of things is also disturbed. A pathological process develops - hypoxia, or oxygen starvation - that is, a condition caused by insufficient intake of oxygenated blood to the cells. In lung diseases, for example, the penetration of oxygen from air into the blood is impeded, as a result of which severe oxidative stress can develop in the cells - alveolocytes, which is accompanied by mitochondrial dysfunction and impaired energy metabolism. And this is already fraught with complications such as respiratory failure and cerebral edema, which has fatal consequences.

Modern science, meanwhile, believes that the human body is fully adapted to protect tissues from hypoxia, you just need to find and start the necessary mechanism in time. A key role in this process is given to the mitochondrial ATP-dependent potassium channel (mitoKATP), and pharmacological activators of this channel are currently being searched in many laboratories around the world.

The results of work on this topic in the journal Scientific Reports were recently presented by the mitochondrial transport laboratory of the Institute of Theoretical and Experimental Biophysics of the Russian Academy of Sciences. By the way, it was in this laboratory in 1981 that this protein channel was first isolated from mitochondria and reconstructed into a bilayer lipid membrane. As activators of mitoK, the ATP channel on many models of oxidative stress in this laboratory has long been studying the nucleotide - uridine.

“In the present work, we first discovered the protective effect of uridine against hypoxic damage to lung tissue, and also showed that the administration of uridine to animals eliminates pulmonary edema and prevents the appearance of ultrastructural mitochondrial disorders - the main cellular“ energy stations ”- comments one of the authors of the article, the head of the laboratory , Doctor of Biological Sciences, Professor, Honored Scientist of the Russian Federation Galina Dmitrievna Mironova.- Such an effect of uridine during the development of tissue hypoxia can play an important, if not decisive, role in optimizing the supply of oxygen to the body. Inhibitory analysis showed that the main reason for the protective effect of uridine is its effect on mitoKATPchannel. The priority in studies of the antihypoxic and protective effects of uridine now remains on our side.”

In the future, it is planned to create a pharmaceutical preparation based on uridine, which will eliminate the development of pulmonary edema, as well as contribute to the prevention and treatment of myocardial infarction, stroke, acute inflammation and other diseases associated with the development of hypoxia.



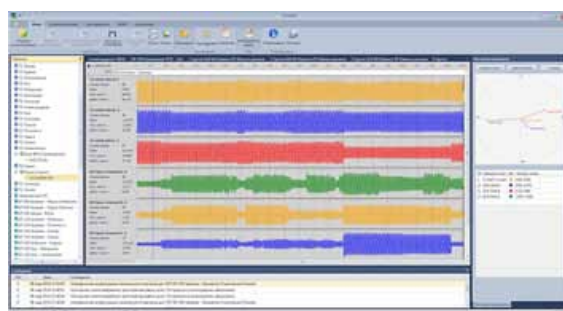
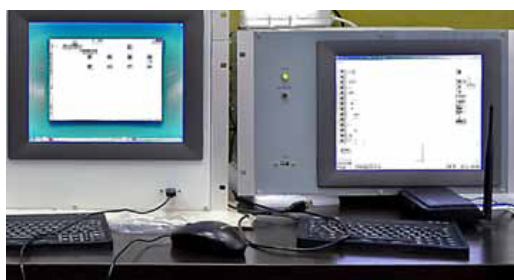
## INNOVATIVE PRODUCTS AND SOLUTIONS

### ENERGY

#### 1. INTELLIGENT RELAY PROTECTION WITH CHARACTERISTICS WHICH ARE INDEPENDENT OF OPERATING MODES OF ACTIVE AND ADAPTIVE ELECTRICAL GRID

##### FIELD OF APPLICATION

The electric grid of 110 kV and higher of OJSC «Rossetti», including OJSC «FGC UES» and their network units. The device is popular on the sites of other network companies of the Russian Federation and abroad.



**DESCRIPTION:** Developed and manufactured intelligent relay protection (IRP) of electrical grids with characteristics that are independent of operating modes of active and adaptive electrical grid is intended for primary and back-up protection and automation of power transmission lines (PTL) of alternating current (frequency 50 Hz).

The use of such devices in electrical power engineering will improve high-speed performance and sensitivity of relay protection of electrical grids. Due to this reliability of grids in general and in particular security of supply of consumers of electricity will increase. For organization of network interaction with APCS via Ethernet communication channel standard IEC 61850 is used.

IRP structure with characteristics that are independent of operating modes of active and adaptive electrical grid includes:

- measuring elements of relay protection on the basis of simplified digital filtering of emergency currents and voltages with 1.5-1.8 times more high-speed performance in comparison with the existing analogues;
- input-output boards of high-frequency signal processing for intelligent relay protection of electric grids;
- IRP unique algorithms which make it possible to provide its operability not depending on parameters and conditions of electrical grid with control technologies of these grids.

#### **KEY SPECIFICATIONS:**

- rated alternating current – 1 or 5 A
- rated interphase voltage of AC – 100 V
- rated phase voltage of AC –  $100/\sqrt{3}$  V
- rated frequency – 50 Hz
- rated voltage of automatic direct current – 110 or 220 V
- rated voltage of direct current of quantized inputs – 24/48/60/110/220 V. IRP conforms to standards on RPAE devices.

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## **2. DESSIMILAR ENERGY SOURCES INTEGRATION DEVICE**

### **IMPLEMENTATION AREA**

Small power. Their electric power supply needs to make from its own power plants, including using renewable sources of power (RESOP): low-power and low-energobalance objects, mobile objects, small settlements, agriculture and extractive industries objects.

## DESCRIPTION

An integration device allows to connect an external source of electric energy with different output parameters (power plants based on fossil fuels, renewable sources of power, advanced models of energy storages, industrial electric system). Therefore it is possible to carry out the power supply of autonomous consumers on the basis of multimodal energy sources (both based on fossil fuels, and renewable energy), providing high energy performance and operating reliability.

### Integration device includes:

- two blocks dosing inductances (in general inductive filters);
- universal voltage convector (connection of DC or AC);
- capacitive storage (bank of capacitors and accumulator bank to ensure accumulation of electric energy);
- three-phase voltage source inverter (formation of three-phase given frequency AC voltage);
- measurement system and protection;
- power interface circuits with control system;
- flexible adaptive control system on the basis of industrial computer. Integration device fulfils the following functions:
- parameters match dissimilar RESOP, electric energy storage and electric energy consumers;
- the best complementary use of dissimilar RESOP;
- energy security of autonomous consumers;
- required quality indexes of electric energy.

The developed technology determines more efficient use of dissimilar RESOP with different parameters of output voltages.

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### 3. DIGITAL TRANSFORMER SUBSTATION OF 10/0.4 KV WITH AUTOMATIC VOLTAGE AND POWER CONTROL

**A**



a) variable dry-running transformer;  
switchboard;

**B**



b) thyristor voltage and power

**C**



**D**



c) operating technology system; d) active and adaptive control system and the  
distributed control and monitoring system

### IMPLEMENTATION AREA

An electric power distribution system of 10 (6) kV, 50 Hz.

## DESCRIPTION

A digital transformer substation (DTS) of 10 / 0.4 kV - a power plant allowing to carry out discrete and modulating control of AC output wide-ranging voltage without switching overvoltage.

DTS consists of:

- a voltage regulator of 400kVA with a split high voltage winding;
- a contactless thyristor unit with automatic voltage and power control on load (ARPN);
- a three-level operating system;
- a low voltage switchgear.

### **DTS capabilities:**

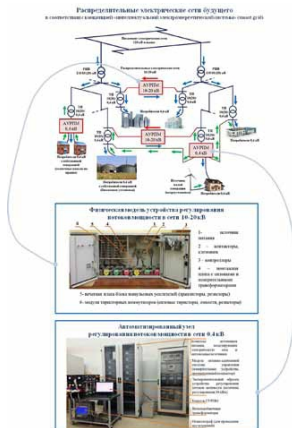
- voltage value transformation and electric energy distribution;
- power value and flow direction regulation on 10 kV side if applicable (a power sources connected to tires of 0.4 kV);
- voltage regulation and balancing of power-consumers of 0.4 kV;
- limiting of switching overcurrents and short circuits currents on 0.4 kV side.

DTS will find application in power supply systems of consumers of 0.4 kV. Application of DTS decreases capacity and electric losses and conduces to reactive power compensation in electric main of 0.4 kV. The latest allows to increase of energy efficiency of low- voltage consumers.

It is supposed that the digital transformer substations will be a basic element of an active and adaptive intellectual electric main in the future.

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#### 4. AUTOMATED UNIT OF TRAFFIC POWER FLOWS' CONTROL IN THE INTELLIGENT ELECTRICAL DISTRIBUTION NETWORK



**PURPOSE:** Control of power flows of electric energy and regulation of voltage characteristics in intelligent networks of low (0.4 kV) and medium (10-20 kV) voltage

**DESCRIPTION:** Intellectualization of electric energy transmission and distribution on low and medium voltage, as well as integration of small power generation sources require transition to new power flow control technologies. For two voltage levels (10-20 and 0.4 kV) scientific and technical

solutions to create automated power flow control units (APFCU) providing controllability and optimization for managing electrical network are developed.

APFCU for 10-20 kV network is a semiconductor phase shifting device (SPSD) as a part of series and shunt transformers; single-phase semiconductor converters with bilateral switches and control systems. The use of the device in distribution networks will make it possible to regulate flows of reactive and active power, change configuration of the distribution network; optimize voltage in load nodes. The distinctive feature of the development is enhanced functionality of the in-phase regulation module and reduction of estimated power transformers in the device.

APFCU for 0.4 kV network is an electrical switchgear with control introductory and automatic line circuit breakers; power flow control device based on low-voltage semiconductor voltage converter with adaptive control system and three single-phase series transformers; current and voltage sensors; two-level control system. Its usage will make it possible to organize bidirectional energy flow between sources and users, control reactive power, improve the quality of transmitted power.

APFCU can be implemented in existing power distribution networks of medium and low voltage and used in transition to intelligent grids of a new generation.

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### 5. STAND-TIP FOR PASSIVE SAFETY EVALUATION OF VEHICLES BODIES



#### PURPOSE

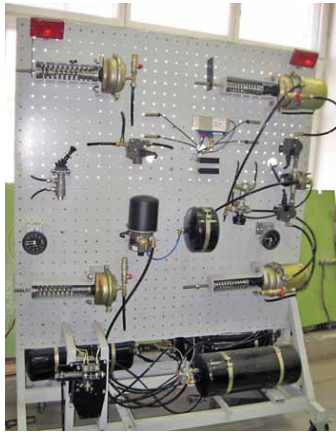
The stand allows to evaluate the safety of body structures in accordance with the requirements of international rules UNECE №66 «The uniform instructions concerning regulatory approval of large passenger vehicles with regard to the top part strength of vehicle's construction». The stand can be used for pre-accreditation tests and safety evaluation of buses bodies. The stand allows to test both separate sections and fullscale vehicles (if two stands are installed).

#### DESCRIPTION

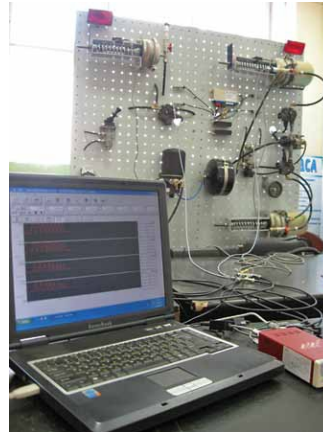
The stand-tip is intended for passive safety evaluation of vehicles bodies sections. The stand includes a base box with racks, a platform turning around and getting through cylindrical hinges as well as long-stroke hydraulic cylinders. The stand-tip allows to carry out experimental researches of strength and carrying capacity of the vehicle bodies sections at rollover a ledge conditions. The stand has a simple, easy taking a construction to pieces. Due to the construction a vehicle can be bolted in a short span of time and on any level concrete (or asphalt) surface. The stand doesn't require any significant maintenance costs and has good corrosion resistance, so it can be installed both indoors and outdoors. The stand is covered by the useful model patent №134870.

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## **6. STAND WITH A PNEUMATIC BRAKE SYSTEM**



**1**



**2**

### **PURPOSE**

The stand allows you to perform the following studies:

- Estimation of the response time of the brake system and its individual components;
- assessment of the level of pressure drop in the circuits of the brake system with multiple braking;
- assessment of the parameters of the brake system when replacing one or more components to the corresponding analogues (components of other manufacturers);
- assessment of the performance of the brake system in the event of failure of one of circuits, or one of the components;
- assessment of the degree to which the brake system retains its key properties before and after life tests;
- study of the operation modes of individual components in conditions simulating processes of the functioning of the brake system.

## DESCRIPTION

The stand consists of a steel frame which is fixed breaks units with a pneumatic drive. Interconnection of components and the length of connecting tubes correct fully the brakes of researched vehicles. Compressed air with pressure of 12 Bar is supplied to the stand (desiccant) from a stationary. The stand is driven with hand brake lever manipulation and touching on a brake pedal (for clarity, stop signals installed at the top of the stand light up). The brakes on the stand are replaced springs and elastic buffers allowing to simulate a nonlinear characteristic of brakes (non-linear dependence rod forces on the rod lengthwise displacement). Pressure change in brakes mains and rods brakes movement are registered during the operational period of the stand.

The stand is covered by the useful model patent №117375.

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## 7. TRANSPORTABLE CENTER OF VEHICLES TECHNICAL DIAGNOSIS



**PURPOSE:** A transportable center of vehicles technical diagnosis (TCVTD) is intended for vehicles health check on the road. Engineering capabilities of TCVTD

allow to carry out a technical inspection of vehicles having centrally loaded up to 3.5 tons (TCVTD-3.5) and 8.0 tons (TCVTD-8.0).

## DESCRIPTION

The transportable center of vehicles technical diagnosis includes an automotive laboratory made on the basis of all-metal light commercial vehicles and two-wheel trailer intended for transporting roll booth and rampants used for vehicle entry on the stand and exit from it.



There are a table, two chairs, a tool box, a rack with equipments: a smoke meter, a gas-analyser, a headlight tester, a glasses light transmission tester, a control linkage backlash tester.

The software allows to take test indications automatically, compare them with the industry standard

and print a test card together with vehicle test results.

TCVTD can operate off line when a gasoline-powered is used. A stand of vehicles brakes diagnosis forming part of TCVTD is covered by the useful model patent №88325.

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## 8. STAND-TIP FOR STATICAL STABILITY EVALUATION OF VEHICLES

### PURPOSE

The stand allows to evaluate of vehicles statical stability in accordance with TRSWV.



## DESCRIPTION

The stand-tip includes a rotating platform set into action with several cylinders. The vehicle installed on the stand is secured from tipping over with safety belts. A stop collar prevents vehicles sliding off the platforms. A roll-over test is until the moment when all

wheels of vehicle end side lose contact with the rotating platform. A height of center of vehicle mass, a lateral-stability coefficient, a dump angle, a roll angle are elicited on completion of testing.



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## **9. USING NEURAL NETWORKS FOR PROBLEM SOLVING OF INDUSTRIAL EQUIPMENTS VIBRATION MONITORING AND FORECASTING OF WORKS TURNING QUALITY**

### **IMPLEMENTATION AREA**

1. Metalworks quality improving through continuous change control of a vibration signal. This approach will allow to predict quality characteristics and make decision on providing work quality characteristics timely.
2. Integrity monitoring of machining facilities due to continuous change control of a vibration signal.

### **DESCRIPTION**

A JAVA program that simulates a neural network (round-trip) is developed. A network structure is developed; a learning algorithm is written; weight coefficients are chosen. Input and output vectors matrix is formed. Training and testing network are realized. Test validity is confirmed. Presented development can be applied at machine-building enterprises to improve workmanship and also to control equipment performance.

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## **10. COMPLEX FOR VEHICLES CHARACTERISTICS ESTIMATION**

### **PURPOSE**

The complex is intended for:

- measurement of power-saving properties of thermally insulated constructions;
- measurement of throat opening factors and movers-bases interaction evaluation.

The complex allows to model an environmental effect thanks to temperature regulation in a wide range, humidity and pressure regulations, and makes tests to determine throat opening factors and movers-bases interaction evaluation.





## 11. AUTONOMOUS MOBILE ROBOTIC SYSTEM



**PURPOSE:** Autonomous mobile robotic system is designed for monitoring coastal zone and marine forecasting of natural disasters. Environmental monitoring is required especially in inaccessible

and dangerous situations on the eastern and northern coasts of Russia where it is necessary to collect information about natural processes occurring on coasts and in seas.



**DESCRIPTION:** Autonomous mobile robotic system (AMRS) consists of a vehicle including a sealed housing with an add-in, power and transmission installations and propellers, a system of vehicle control and a system of motion control and devices for collection, processing and transmission of information

about natural processes, others devices for information storage, communication and control, power supply systems. The main body can be attached and powered by propellers in contact with track surface: wheeled, tracked or rotary-screw propellers. The main body also has an add-on which includes hatches controlled remotely, a mast and sliding rotating platforms mounted with navigation equipment of positioning AMRS and devices for environmental monitoring. Thus, not depending on soil conditions (bearing capacity of soil) and topographical relief (roughness of the way, single obstacles, etc.) AMRS overcomes the way from the control point to the survey area using one of the types of propellers (wheeled, tracked or rotary screw), takes the observation point with given coordinates of control center in automatic mode (on the program of on-board control system), operates the devices monitoring the environment, collecting and processing information. Transformation of databases

generated by the onboard system to the control center on volume and time is defined by the control center.

At the end of surveying of the specified area or by the command of the control center AMPS stops monitoring devices offline and returns to the control point by the map recorded way.

The results are achieved at financial support of Ministry of Education and Science of the Russian Federation (Agreement № 14.574.21.0089, unique identifier of the agreement – RFMEFI57414X0089).

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## **12. CROSS-COUNTRY VEHICLE ON LOW PRESSURE TIRES WITH AXLE CONFIGURATION 8X8**



### **PURPOSE**

Safe year-round transportation in northern regions with difficult climatic conditions and extreme ecological vulnerability in deteriorate road conditions on impassibility and virgin snow with the possibility of overcoming water obstacles.



**Description:** Cross-country vehicle on low pressure tires with axle configuration 8x8 (CCV) has high maneuverability, mobility and energy efficiency when driving on supportstructure with low bearing capacity and overcoming water obstacles.

Cross-country vehicle is based on modular and unitized principles, has an optimal layout which makes it possible to create all-wheel drive and fully controllable vehicles of different purpose with axle configuration 4x4, 6x6 and 8x8 (passenger, cargo, cargopassenger, with special upper structures, rescue vehicles, etc. ).

The maximum speed of the vehicle on hard surface is not less than 80 km/h, acceleration time on 1000 m way is no more than 63 s., fuel consumption is 27.5-30 l/100 km, speed on water is not less than 6 km/h.

High indicators of performance characteristics are attained by optimal combination of engine parameters, original transmission with command and automatic control, propeller with all steering wheels, brake control and suspension of advance efficiency, frames-boats and cabins with capacity of 7 people.

Using original innovative technical solutions, environmentally safe technologies, modern scientific research in frame-boat design, automatic transmission, steering system, cushioning system and chassis led to improved performance terrain, amphibious characteristics, fuel efficiency, comfort of vehicle driving, reliability at lower cost compared to existing analogues.

The project is developed at financial support of Ministry of Education and Science of the Russian Federation (Agreement №14.577.21.0080 from 05.06.2014).

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### **13. MULTIFUNCTIONAL CROSS-COUNTRY VEHICLE**

«ALDAN» EQUIPPED WITH INTELLIGENT

WHEELED RUNNING GEAR DRIVE SYSTEM

#### **PURPOSE**

Moving and implementation of transport and technological operations on roads of all categories; in cross-country conditions, including deformable bearing surfaces (snow, sand, swamps) and on rough terrain; overcoming water obstacles by wading and swimming.



#### **CONSUMERS**

The main applications of these vehicles are transport providing of gas and oil fields; construction, repair and inspection of linear facilities (pipeline routes, power and communication lines); transportation of topogeodesic, geological and drilling units over the tundra while maintaining the integrity of soil covering of northern biogeocenoses.

## DESCRIPTION

Equipment of «Aldan» cross-country vehicle with hydrostatic transmission makes it possible to achieve rational power distribution (torque) on drive wheels depending on conditions of their interaction with bearing surface which provides significant increasing in average speeds of machine movement in difficult road conditions (maximum possible linkage traction strength by automatically maintaining the required level of external wheel slip is implemented).

At the same time it provides minimum energy consumption when wheels interact with bearing surface (fuel economical efficiency is improved) and environmental safety of the track mover when operating on vegetative ground cover. Installing the hydrostatic transmission makes it possible to optimize the constructive layout scheme due to choosing of placement of transmission units.

The integrated combination of active wheel drive, tires of low pressure, independent springing system, steering schematic with steering wheels of two front axles when driving on weak soil helps to perform transport operation with preservation of ecology of the soil covering.

The results are achieved at financial support of Ministry of Education and Science of the Russian Federation (Agreement № 14.574.21.0107 (unique identifier of the agreement – RFMEFI57414X0107)).

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#### **14. SAFETY, LIFE IMPROVEMENT AND REDUCTION IN METAL CONSUMPTION OF INDUSTRIAL EQUIPMENTS AND VARIOUS METAL STRUCTURES IN SERVICE**



##### **IMPLEMENTATION AREA**

The research findings concerning service life of equipments and metal structures are brought in enterprises of aircraft and automotive industries. Thus, a structural behavior stability of pressed parts PAP buses, their service life in the air and in a corroding agent are improved; grade slates, steel grade are reduced in industries; metal consumption of a bus is reduced through reducing parts thickness. (Metal consumption of one PAP- 3205 is reduced

by  $\approx 5\%$ , or 100 kg).

##### **DESCRIPTION**

Tips for processing treatment of 12X18H10T, ЭИ878, BHC-2 and etc. (GAPO n.a. S. Ordzhonikidze), steel 40X (development of advanced manufacturing technologies of critical fasteners, LLC «Rus-Metiz», Orel) are developed. They allow to increase the service reliability of long bolted components, to be indifferent to occurrence of thread defects and get proportional strength and past-forming properties of calibrated steel rolling 40X along the full length of a bobbin. Besides, the possibility of quench cracking is eliminated; the necessity of long bar components is disappeared (Fig.).

The developments are covered by patents: G.V. Pachurin, A.A. Filipov, V.G. Pachurin «Treatment method of hot-rolled steel», application № 2012125329, priority on June 18, 2012 registered 27.06.2013.

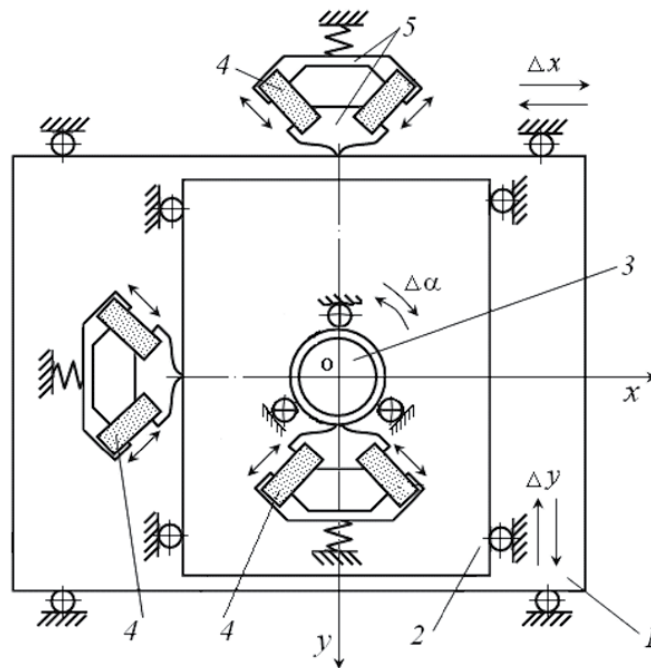
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## 15. PRECISION COORDINATE NANOSYSTEMS ON THE BASIS OF AN INVERSE PIEZOEFFECT

**Fig. A**



**Fig. B**



The circuit of three-axis table on the basis of piezoceramic transducers (a) and its general view (b)

### IMPLEMENTATION AREA

High-precision coordinate drives on the basis of an inverse piezoeffect are indispensable when they are used in advanced high processing technologies of

microelectronics (LSI and VLSI), printed-circuit boards, microsurgery, nice geodetic instruments.

## **DESCRIPTION**

The blocks of two piezoceramic transducers 4 (PCT) set to an angle  $90^\circ$  to each other (see Fig. and picture) contact with the fork carriages 1,2 and the rotary table 3 in 3-D system of exact positioning.

The contact is via a special holder 5 made from hard steel and an application force is regulated by means of a spring. Clutch between the holder and the fork carriage is realized with solid friction forces and the fork carriage movement occurs with highfrequency (HF) oblique impacts. Reversal of the fork carriage movement is performed with switching of PCT in the block.

## **SPECIFICATIONS OF DRIVEN PFS ON THE BASIS OF THE INVERSE PIEZOEFFECT**

PFS operate in a nanoscale of object transfers:

- in translational axes  $x, y$  - from 100 to 1 n (instead  $\pm 10$  microns according to a fundamental-mode scheme);
- in an angular coordinate  $\varphi$  - from 10 to 1'.

A constant speed movement basis, the specified motion laws with motion monitoring in a wide range are performed.

Piezoengines allow to establish systems of exact positioning with a controlled structure.

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## 16. RESEARCH AND DEVELOPMENT IN WHEEL WEBS REPAIR TECHNIQUE



Bolting and screwing model test of a new clastic stand in arriving at stand strainstress state in «SolidWorks 2007»



### IMPLEMENTATION AREA

The mechanical engineering department of Arzamas State Technical Institute (branch of NNSTU n.a. R.E. Alexeev) and LLC «Diskplat» carry out of research in the field of webs repair technological advancement

for wheeled transport.

A stand model for wheel webs dressing of cars, motorcycles, mopeds and scooters is developed. A rim diameter is from 10 to 22 inches. It has no equals. The model remedies the webs defects of small vehicles with the use of stock-produced stands for automobile webs dressing.

## DESCRIPTION

An added accessory by way of idle mandrels for small motor transports webs orientation on batch-produced stands is included in package contents of batch-produced stands. Additionally, special washers and extra-long screws to band webs up are also used. Method of webs dressing is learnt to motorcycle and scooters webs. Now a prototype stand with options is being manufactured for the exhibition. If small enterprises do car repairing use the new stand they'll solve problem of small vehicles webs repair with minimum expense not to be compared with webs dressing centers in a capital.

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## 17. CUTTING PROCESS DIAGNOSTICS IN REAL TIME

### PURPOSE

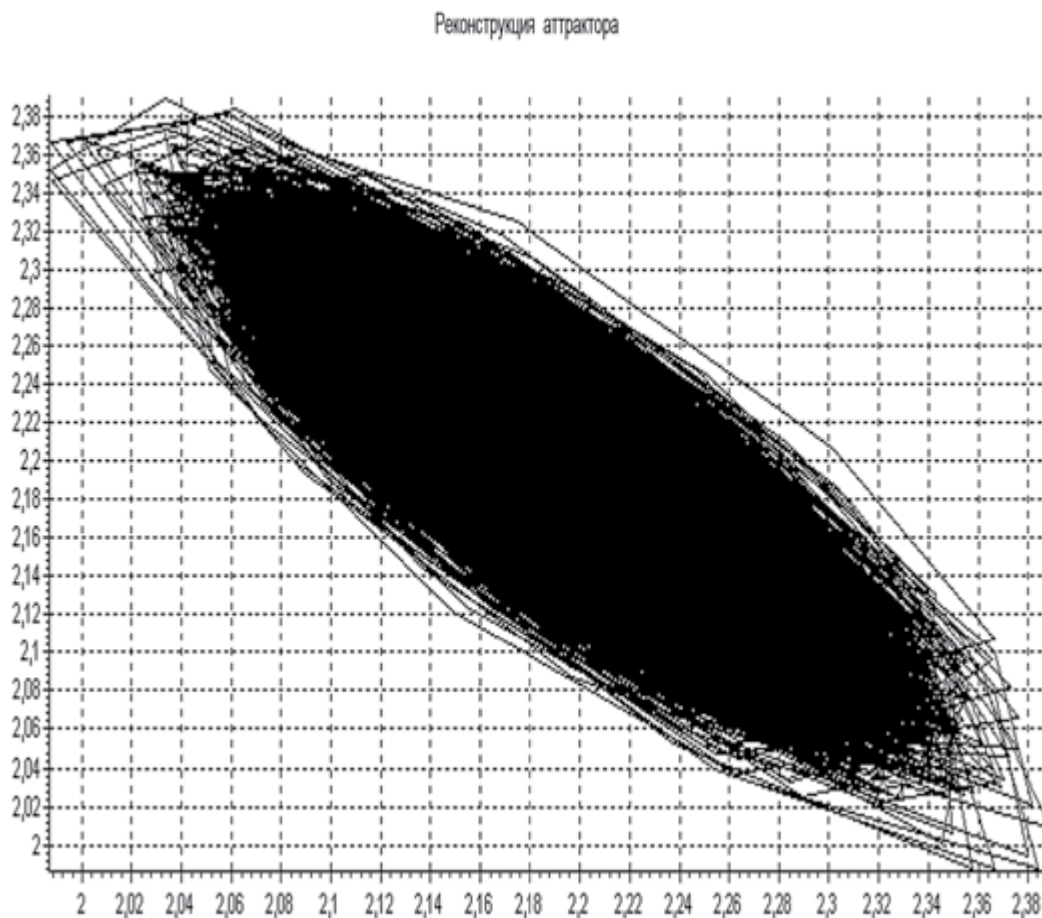
Hardware and software are developed for CNC cutting process diagnostics with the use of nonlinear dynamics approaches, fractal and wavelet analyses.

### DESCRIPTION

A cutting system is a complex, nonlinear dissipative structure from physical standpoint.

Therefore, dynamic state of the system including tool wear rate at a time as well as tendency of the system evolution must be estimated. The fractal analysis of the system phase field and the wavelet analysis of a vibration signal received from a cutting zone is implementation.

Empirical data show that the type of attractor and its fractal dimension change with increase of flank wear land when steels are turned. The system attractors in flank wear land  $h_3=0.15\text{mm}$ . and  $h_3=1.1\text{mm}$  are presented in the picture.



*Cutting system attractors in flank wear land  $h_3=0.15\text{mm}$  and  $h_3=1.1\text{mm}$*

The system energy doesn't dissipate in workspace thereby reducing process stability and performance in the system with a tool wear  $h_3=1.1\text{ mm}$ . Thus, if the tool wear is advanced the attractor type changes. Thus, the dynamic system evolves in time. There is the specific attractor type and fractal dimension for specific technological conditions at some cutting tool wear

The use of the wavelet analysis of the vibration signal allows to reveal transients in midcut and prevent a product or equipment failure.

The use of AI systems allows to predict the tool wear and the system behavior in real time.



The cutting system behavior change information allows to generate a control signal revising treatment process in real time (using CUDA-technology).

*Machine-Building Technology and Equipment Department*

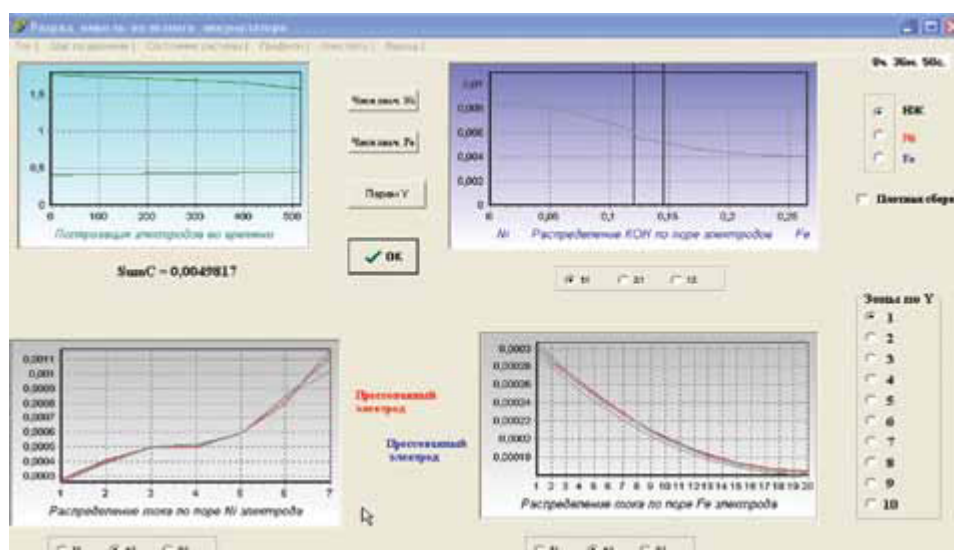
*Person of contact: Y.G. Kabaldin, D.Sc. in Engineering, Professor*

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## 18. SOFTWARE PACKET FOR MATHEMATICAL SIMULATION THE PROCESS IN CHEMICAL POWER SOURCES

### IMPLEMENTATION AREA

Making chemical power sources with a high specific performance, modeling the processes in porous electrodes, improving the way of chemical electrodes making.



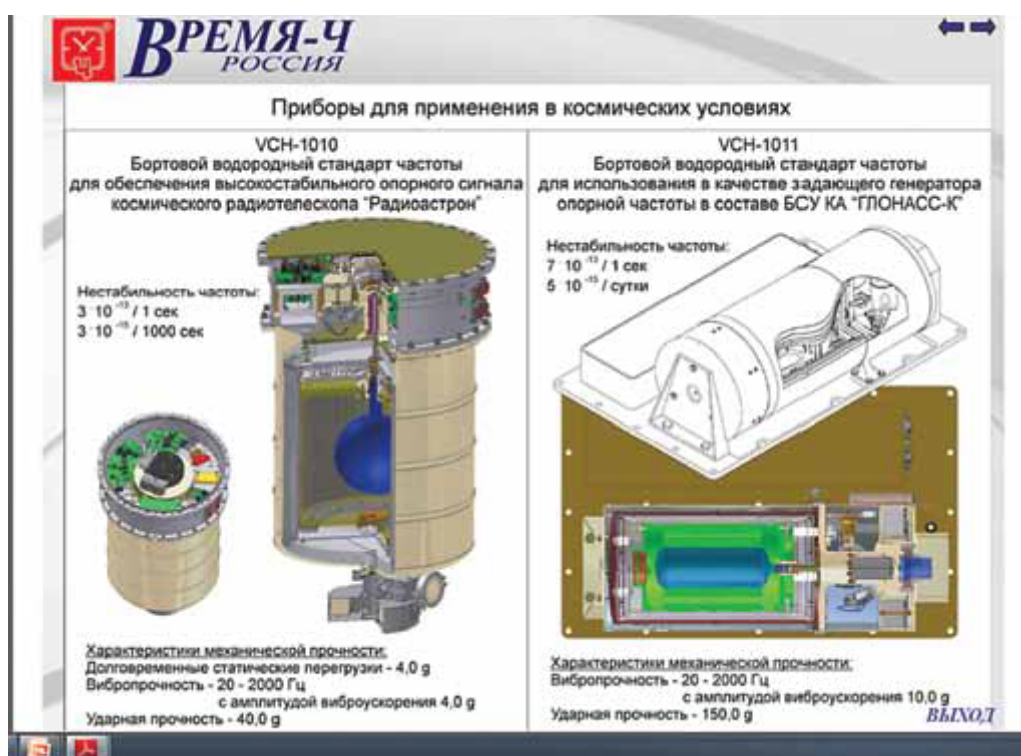
## DESCRIPTION

Making a new type of alkaline power source is a long and hard process. To speed up the new accumulators developing the software packet was made. It may compute discharge characteristics of power battery at different operating terms.

*Organic Substances Technology Department*

*Contact persons: PhD in Technology Science, Professor Y.L. Gunko, Assistant Professor O.L. Kozina, Contact number: (831) 436-83-73, E-mail: [tep@ntu.nnov.ru](mailto:tep@ntu.nnov.ru)*

## 19. GETTER MATERIALS FOR DEGASIFIERS



## IMPLEMENTATION AREA

Getter materials are intended to absorb hydrogen within on-board hydrogen frequency standard VCH-1011 for the use as a master frequency generator as part of DMU SPACECRAFT «GLONASS-K».

## DESCRIPTION

The getter materials are a composition of titanium and vanadium powders processed into a porous strip with a method of cold rolling with a fixed surface area.

Now there are high requirements to operational characteristics of a whole range of traditional and newly developed vacuum devices whose operation is connected with application of porous getters, pumping molecular hydrogen and other gases.

The porous getters process with a method of a complex shape rolling is developed within the frame of an economic contract with CJSC «Time-CH»

Preconceptual studies are carried out to improve the sorption properties of the getter materials on the basis of a titanium-vanadium composition.

*Metal Science, Materials Technology and Metal Heat Department*

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## 20. FUNCTIONAL MATERIALS OBTAINED WITH METHOD OF METALS AND NONMETALS POWDERS ROLLING

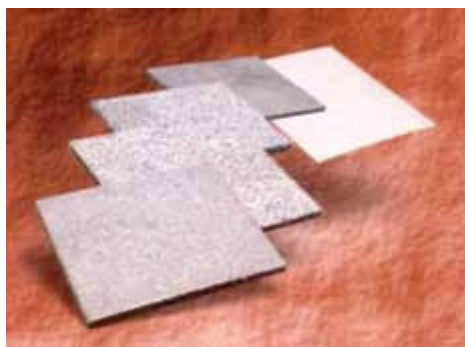


Fig 1



Fig 2

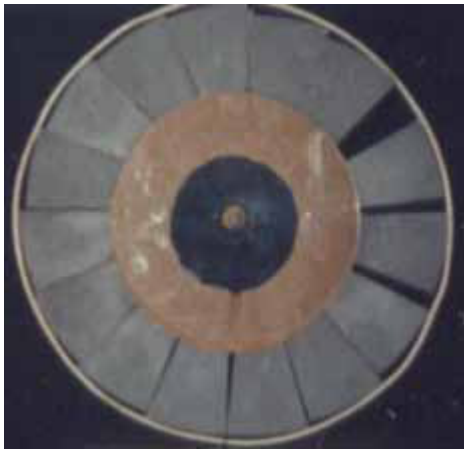


Fig 3

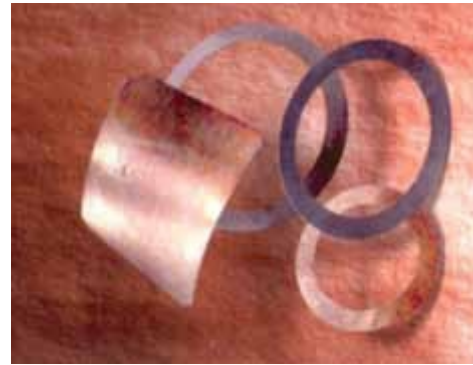


Fig 4



Fig 5

### **FILTER ELEMENTS MADE FROM POROUS**

TITANIUM SHEETS TEMPERS PT/F AND  
PT/GM (fig. 1)

Porous titanium sheets are intended for fine filtration of liquid and used as a de gasifier in chemical current sources.

SHEET PACKING AGENTS GRADES UMB  
AND NGP (fig. 2)

Sheet packing agents grades UMB and NGP are used in setting seal groups of gas turbines and other units.

High temperature sheet packing materials are made from nichrome based mixtures grand ПХ20Н80 and boron nitride, as well as from a nickel-plated graphite powder with rolling, sintering, hot rolling and annealing.

## TARGETS FOR THIN-FILM DEPOSITION

(fig. 3)

Targets for thin-film deposition are used to obtain resistive films in electrical engineering.

Material: both one-component compounds (cobalt, nickel, antimony, scandium, chromium and others) and multi-component compounds of non-ferrous metals received with a method of powder metallurgy.

## REPLACEABLE INSERTS TEMPERS

BRAS – 100; 75; 50 (fig. 4)

Replaceable inserts tempers BRAS – 100;75;50 are intended for making of cutting elements that are used to process sheets made from hard and brittle non-metallic materials.

Sheet iron and plate iron with the use of copper, nickel, tin and synthetic diamonds powders and incurred multi-stage thermo-deformation processing.

*Metal Science, Materials Technology and Metal Heat Department*

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## 21. LASER MICROANALYSIS

### DESCRIPTION

Laser microanalysis is performed on gases, alloying elements and harmful impurities in the transition zone of welds and other dissimilar joints materials, as well as in the study of chemical heterogeneity on a crystalline scale hardwood grains of cast metals and alloys. The laser beam allows you to analyze:

- refractory and highly conductive metals;
- colored silicate and quartz glasses;
- ceramics;

- minerals;
- plastics;
- coatings of varnishes, paints and metals;
- plant and animal tissues.

Microanalysis is performed on a laser microspectroanalyzer "LMA-10" company "Carl Zeiss" Germany. The principle of operation of the device is to vaporize grain beam of a microvolume of matter from the surface of the material, spark ionization vapor cloud with subsequent registration of the spectrum of the analyte on Q-24 and PGS-2 spectrographs, or on a mass spectrometer. Minimum depth funnels of the evaporated material -1  $\mu\text{m}$ , the minimum diameter is 5  $\mu\text{m}$ .

## **FACILITIES**

The Specialists of the NSTU laser center will help interested enterprises:

- Draw up a business plan and carry out a feasibility study forest organization of the laser site;
- Select and purchase the necessary laser equipment and software managed tooling;
- Develop a technological design of the laser section with reference to the essential existing production;
- Master the laser processing process and conduct training attendants.

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## 22. COMPLETE GYRO SENSOR WITH ELASTIC

MEMBERS, MADE WITH WHOLE BLANK OF 44 HXTIO STEEL TYPE



### PURPOSE

Gyro sensors are used for precise guided- object control in the terms of constant rotation axis related to inertial space. It is performed by resistance to ill-effect from different energies (mechanic, vibrant, thermal, electromagnetic) in poor operating terms: (broad-band random vibration with Root-Mean Square  $\varepsilon = 13g$  at frequencies  $\Delta f = 20 - 20000$  Hz; at shock vibrations with acceleration up to 80 g).

### DESCRIPTION

This type of gyro sensor has got inner cardan suspension where elastic connectors (0,065 mm in depth) are used as working pieces keeping the material strength and the constructive reliability. Demanded work stability during 12-12 years is provided with keeping the 44 HXTIO steel qualities in interval from -600 C to 850 C of dynamic stress.

*Producing method for elastic hanger of dynamic tuned gyroscope.*

*Patent № 2492422 from 13.09.2013.*

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