



This edition is dedicated to the achievements and developments of Voronezh State University researchers. VSU is a competitive and successful university in the field of research and development.

For many years, VSU has been included in prestigious rankings of the best universities in the world.

In 2020, VSU for the fourth time became the best university in the annual competition for innovative projects "Innovation cup" held between Voronezh universities. The competition is aimed at discovering research findings which are in high demand on the market. It is very encouraging for our researchers who have been working successfully on the federal level and want to show how VSU influences their native region in the sphere of innovation.

The university has created an advanced system for R&D, strengthening the innovative industries. We have implemented a few large hi-tech production projects based on the chain "fundamental research – applied research – innovative project – production of the project"

In the "Atlas of Innovations" you will find projects dedicated to physics, chemistry, mechanical engineering, information technology, pharmaceuticals, and biotechnologies. You will also find out how the staff of the university worked on different projects and you will learn about the profitability and the cost of each project.

We are sure you will find some really fascinating information in here.

*VSU Rector, DSc in Economics,  
Professor D. A. Endovitsky*

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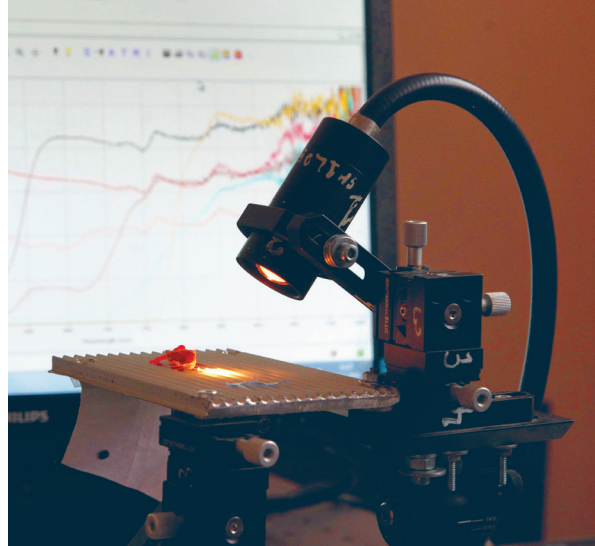
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#### ■ PROJECT PRODUCT

High-speed video module based on industrial linear sensors of visible and near IR radiation for various computer vision systems.

#### ■ ADVANTAGES OVER EXISTING ANALOGUES

Much lower price, precise adjustment mechanism for optimal positioning and tuning of the video modules, flexible and user-friendly software that can be used for various sorting tasks.

#### ■ DURATION OF THE PROJECT

2017–2019.

#### ■ PROJECT PAYBACK TIME

The project already generates profit.

## MULTIFUNCTIONAL HIGH-SPEED VIDEO MODULE BASED ON INDUSTRIAL LINEAR SENSORS OF VISIBLE AND NEAR IR RADIATION



The video module registers moving objects line by line, converts received video data into a digital format, processes the lines (frames) of the image using special algorithms and determines the output signals. The module includes an image receiver (a monochrome or an RGB sensor), a signal coder, and a digital signal processor. The analogue output data is digitalised by the analogue-to-digital converter (14 bit) and transmitted to a special signal processor, a dual Analog Devices BF561 Blackfin processor. The video module is controlled and connected through an industrial RS-485 interface. Using this interface, it is possible to develop industrial networks employing a large number of video modules. The output signals of the module are presented in the form of 4 digital differential pairs capable of delivering consecutive data transfer with a frequency of up to 30 MHz. This project was implemented in accordance with the Decree of the Government of the Russian Federation dated 9 April 2010 No. 218 "On measures of state support for the development of cooperation of Russian higher education institutions and organisations implementing complex projects with high-tech production within the framework of the sub-programme "Institutional development of the research sector" of the state programme of the Russian Federation "Science and technologies development" for 2013-2020.



## ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The video modules belong to OOO Voronezhselmash which is also the major consumer.

## ■ STAGE OF PROGRESS

OOO Voronezhselmash together with a team of physicists from Voronezh State University (Research Institute for Physics and the Faculty of Computer Sciences) have designed a product line of colour sorting machines, including models that simultaneously analyse images from several video modules working in different spectral intervals.

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Patent 2367832, Russian Federation, MPK F16K 31/02 (2007.11) Quick-acting electromagnetic valve / patent holders: G. V. Chuiko, V. D. Strygin, B. A. Zon, G. V. Pakhomov, A. A. Churikov, V. A. Shulgin; authors and patent holders: G. V. Chuiko, V. D. Strygin, B. A. Zon, G. V. Pakhomov, A. A. Churikov, V. A. Shulgin; published 20.05.2009, statement No. 26.
- Utility model patent, RU83436 U1 Russian Federation, MPK B07C5/342 (2006.01) Sorter to grade grain to colour / authors: G. V. Chuiko, V. D. Strygin, G. V. Pakhomov, A. A. Chyurikov, V. A. Shulgin, A. A. Ageev, Ya. I. Shkiryay; patent holder - OAO Voronezhselmash; published 10.06.2008, statement No. 16.
- "Laser sorter" / authors: E. M. Babishov, V. A. Goldfarb, D. A. Minakov, G. V. Pakhomov, V. D. Strygin, G. V. Chyuiko, A. A. Chyurikov, V. A. Shulgin; patent holder - OAO Voronezhselmash.
- "Fibre-optic laser-based sorting machine" / authors: E. M. Babishov, V. A. Goldfarb, D. A. Minakov, G. V. Pakhomov, V. D. Strygin, G. V. Chyuiko, A. A. Chyurikov, V. A. Shulgin; patent holder - OAO Voronezhselmash.

## ■ COMMERCIALISATION RISKS

- Volatility of the currency market.
- Overrated sales market.
- High requirements to the qualification of the employees.
- Lack of efficient maintenance services.



## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

OOO Voronezhselmash, a team of physicists from FSFEI HE VSU.

## ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

160,000,000.

## ■ SOURCES OF FUNDING

- Sources of funding – investments by OOO Voronezhselmash.
- National foundations (Skolkovo, the Fund for Promotion of Small Enterprises in Scientific and Technical Field, grants from the Ministry of Education and Science, etc.).
- Investments by FSFEI HE VSU.
- Internal financing.

## ■ PROJECT PRODUCT

A wide range of high-performance emollients, foam boosters, and foam viscosity increasing agents based on plant oil and fibre, as well as emollient compositions, foam booster compositions, and viscosity compositions used in cosmetic industry.

## ■ ADVANTAGES OVER EXISTING ANALOGUES

The competitiveness of the suggested products is based on their lower production cost as compared to foreign and Russian analogues, due to the fact that the enterprise uses its own raw materials (sunflower, soya-bean oil, and palm oils) and waste products from oil and fat production, as well as advanced production technologies.

## ■ COMMERCIALISATION RISKS

- Price and currency exchange rate fluctuations.
- Manufacturing risks (equipment failure, various defects).
- Force Majeure.

# DEVELOPING AN INDUSTRY FOR PLANT OIL AND FIBRE PROCESSING AND THEIR TRANSFORMATION INTO NON-FOOD PRODUCTS

The goal of the project is the design and development of production technologies for new surface-active material compositions based on natural raw materials, including oil and fibre, and their processing waste in the framework of the construction of a fat-containing waste recycling plant.

## ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The prospective consumers of the developed emollient compositions, foam booster compositions, and viscosity compositions are enterprises manufacturing hard and liquid soap, cosmetics, personal hygiene products, household chemicals and cleaners (liquid and powder), foam concrete blocks, etc.

Within the framework of the programme for improving its environmental efficiency, OAO EFKO has set up its own hard soap and soap flake manufacturing (both lye and toilet) with the developed innovative additives.

The capacity of the main production line is 6 tons per hour, i.e. 49 thousand tons in one year.

## ■ STAGE OF PROGRESS

Production technologies were developed and introduced for new surface-active substances based on natural raw materials, including oil and fibre, and their processing waste.

A technology was developed for:

- The production of emollient compositions based on natural materials.
- The production of foam booster compositions based on natural materials.
- The production of viscosity compositions based on nanocrystalline cellulose produced from plant industry and sugar industry waste, including the dust of sugar beet pulp (fractions of less than 0.1 mm).

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Patent No. 2540867, Russian Federation, MPK C07D307/14, C07D307/14. Method of obtaining N-acylprolines containing residues of fatty acids / H. S. Shikhaliev, A. Yu. Potapov, N. V. Stolpovskaya, M. Yu. Krysin, A. V. Zorina, I. E. Karpeeva, P. A. Kartavtsev; author and patent holder: Federal State-Funded Educational Institution of Higher Professional Education "Voronezh State University" (RU), — No. 2013155247; submitted 13.12.2013; published 10.02.2015, statement No. 4. — 6 p.
- Patent No. 2540868, Russian Federation, MPK C07D307/14, C07D307/10. Method for production of tetrahydrofurfurylamides of vegetable oil fatty acids / H. S. Shikhaliev, A. Yu. Potapov, N. V. Stolpovskaya, M. Yu. Krysin, A. V. Zorina, A. A. Kruzhilin, A. A. Grineva; author and patent holder: Federal State-Funded Educational Institution of Higher Professional Education "Voronezh State University" (RU), — No. 2013155248; submitted 13.12.2013; published 10.02.2015, statement No. 4. — 6 p.

- Patent No. 2571960, Russian Federation, MPK C07C231/02, C07C233/01. Method for obtaining morpholylpropylamides of fatty acids of vegetable oils / H. S. Shikhaliev, A. Yu. Potapov, N. V. Stolpovskaya, M. Yu. Krysin, A. V. Zorina, A. A. Kruzhilin, A. S. Peregudova; author and patent holder: Federal State-Funded Educational Institution of Higher Professional Education "Voronezh State University" (RU), — No. 2014128304; submitted 11.07.2014; published 27.11.2015.
- Patent No. 2573831, Russian Federation, MPK C07C 231/02 (2006.01), C07C 233/46 (2006.01), C07C 233/47 (2006.01), C07C 233/49 (2006.01). Method for obtaining surface-active substances, based on soya isolate and methyl ethers of fatty acids of vegetable oils / H. S. Shikhaliev, M. Yu. Krysin, N. V. Stolpovskaya, A. V. Zorina, D. V. Lyapun; author and patent holder: Federal State-Funded Educational Institution of Higher Professional Education "Voronezh State University" (RU), — No. 2014128303; submitted 11.07.2014; published 27.01.2016.
- Patent No. 2605932, Russian Federation, MPK C07C 303/32 (2006.01), C07C 303/20 (2006.01), C07C 309/17 (2006.01), C07D233/14 (2006.01). Method of producing sulfosuccinates of alkanolamides of fatty acids of vegetable oils / H. S. Shikhaliev, M. Yu. Krysin, N. V. Stolpovskaya, A. V. Zorina, D. V. Lyapun; author and patent holder: Federal State-Funded Educational Institution of Higher Professional Education "Voronezh State University" (RU), — No. 2015142642; submitted 08.10.2015; published 27.12.2016, statement No. 36.
- Method for obtaining of vegetable oils fatty acidsmorpholine-4-ilpropylamides betaines: invention patent No. 2624819 / H. S. Shikhaliev, M. Yu. Krysin, A. V. Zorina, N. V. Stolpovskaya, I. E. Karpeeva, A. A. Kruzhilin. — Moscow, 2017. — (application No. 2015142644, submitted 08.10.2015, Registered in the state register of the Russian Federation on 07 July 2017, published 07.07.2017. Statement No.19).
- A method for obtaining ethers of oxy-acids and monoethanolamids of fatty acids of vegetative oils: invention patent No. 2619118 / H. S. Shikhaliev, M. Yu. Krysin, A. V. Zorina, N. V. Stolpovskaya, D. V. Lyapun, A. Yu. Potapov, A. S. Peregudova. — Moscow, 2017. — (application No. 2015150268, submitted 25.11.2015, Registered in the state register of the Russian Federation on 12 May 2017, published 12.05.2017. Statement No. 14).



#### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

The project was initiated by OAO EFKO of the EFKO Group of companies.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

360,000,000.

#### ■ SOURCES OF FUNDING

- 50% (180 million roubles) — federal budget,
- 50% (180 million roubles) — extra-budgetary financing — investment by the industrial partner.

#### ■ DURATION OF THE PROJECT

2013 г. по настоящее время.

#### ■ PROJECT PAYBACK TIME

4 years.



### ■ PROJECT PRODUCT

Nuclear physical and X-ray diagnostic methods for nanomaterials.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

Scientific and technological potential, detailed study of the fundamental basis of the developed diagnostic techniques.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Two applications for invention patents of the Russian Federation were submitted to the Federal Institute of Industrial Property.

### ■ COMMERCIALISATION RISKS

- Decrease in investment programmes by potential consumers as a result of financial instability.
- Lack of technological readiness of the enterprise.
- Uncertainty with regard to the expected investment income.

## DEVELOPMENT AND ENHANCEMENT OF NUCLEAR PHYSICAL AND X-RAY DIAGNOSTIC METHODS FOR NANOMATERIALS



Various nanostructures, including silicon-based ones, are of a great scientific interest as owing to their special physical properties they can be used in the most advanced areas of science and technology, for example, nanoelectronics, optoelectronics, spintronics, etc. The main mechanisms and peculiarities of electronic energy spectrum and other physical properties in the process of transfer from high-volume crystalline materials to nanosized objects have been poorly studied.

Certain characteristics of interphase, interlayer, and other structural interactions in nanostructured silicon-based systems have also been poorly studied in relation to the optimisation and stabilisation of their advantageous properties.

On the other hand, fundamental science has formidable analytical methods to obtain detailed and highly precise information about electron energy structure of promising objects and nanostructures, including hybrids. Among such methods are nuclear-physical and X-ray methods for nanomaterials diagnostics. The stability of material characteristics used in semiconductor and IC equipment significantly influences their performance and reliability.

This influences the development of various devices, optimisation of production conditions, and their production as a whole.

For example, silicon oxide and nitride, which are used for the passivation of high voltage devices, have a number of disadvantages: electron and ion charges accumulated in the passivation layer influence the space charge region, there are immobile positive charges in the silicon oxide layer in the contact area with Si-wafer that cause crystal parameter instability and decrease in the percentage yield.

Today, the constant increase in product standards leads to a constantly increasing demand for new technologies and new research methods for function materials. Hence, the existing analytical methods used in production do not allow fully studying the structure, phase and quantitative composition of the functional layers used in the production of semiconductor equipment.

#### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The developed technologies can be demanded by Russian semiconductor production companies: OAO Angstrom, FGUP Pulsar, OAO NIIME and Micron, and ZAO Group of Companies EL.

For example, ZAO VZPP Micron needs technologies allowing to generate stabilised coatings for the passivation of high voltage devices.

The enterprise has technological capabilities for the formation of layers of a number of dielectric coatings: thermal silicon dioxide SiO<sub>2</sub>, low-temperature SiO<sub>2</sub> (HT SiO<sub>2</sub>), medium temperature SiO<sub>2</sub> (CT SiO<sub>2</sub>), medium temperature phosphosilicate glass, silicon nitride Si<sub>3</sub>N<sub>4</sub>, silicon oxynitride, polyimide, and polycrystalline silicon.

One of the particular features of the production of semiconductor equipment is their high integrity and stability of the materials' characteristics.

Among other potential consumers of the project's results can be steel industry companies (where high precision element, phase, and structural analysis are needed).

#### ■ STAGE OF PROGRESS

The following diagnostic techniques were developed:

- Ultrasoft X-ray spectroscopy diagnostics of electronic structure and phase composition of thin-film silicone-based nanostructures.
- Diagnostics of non-destructive phase analysis of surface and subsurface layer of experimental samples of thin-film silicone-based nanostructures.
- Moessbauer spectroscopy-based diagnostics of hybrid biological nanoobjects (Dps proteins).



#### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Evelina Domashevskaya,*

Head of the Department of Solid-State Physics and Nanostructures of Voronezh State University, DSc in Physics and Mathematics, professor.

#### ■ DURATION OF THE PROJECT

2014 г. по настоящее время.

#### ■ PROJECT PAYBACK TIME

5 years.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

20,830,000.

#### ■ SOURCES OF FUNDING

- 15,430,000 roubles – federal financing.
- 5,400,000 roubles – Industrial partner financing.

**PROJECT PRODUCT**

A technology for the synthesis and application of thin films allowing the intensity of laser radiation to be controlled. The main working components limiting optical radiation are hybrid associates of colloid quantum dots and dye molecules.

## DEVELOPMENT OF LOW-THRESHOLD LIMITERS OF VISIBLE OPTICAL DENSITY BASED ON HYBRID ASSOCIATES OF COLLOID QUANTUM DOTS AND DYE MOLECULES



Due to the active development of photonics and enterprise and production technologies based on it, devices are required that allow controlling the intensity of radiation to protect eyes as well as the intensity of various appliances and devices (photoelectron multipliers, photodiodes, etc.).

The aim of the project is to develop passive low-threshold limiters of visible optical density based on hybrid associates of colloid quantum dots and dye molecules.

The main problem that this project can solve is the creation of a system to manage optical radiation parameters, i.e. a fast-responding protection for optical radiation receivers with the response time of less than 10 nanoseconds.

This condition is determined by mass usage of impulse lasers used in medical (ophthalmological, oncological, and dental surgery), industrial (metal etching and marking, surface quenching, and processing of ultrahard materials), and research activities.

**ADVANTAGES OVER EXISTING ANALOGUES**

The major advantages of passive limiters of optical density based on colloid quantum dots and dye molecules is the possibility of creation of various thin films, coatings, and colloidal solutions that can be used in different areas of science and technology.



### ■ STAGE OF PROGRESS

- A technology for the synthesis of colloid quantum dots was developed and tested.
- Nonlinear optical properties of such nanostructures as colloid quantum dots and organic dye molecules were studied.
- A method for the conjugation of organic and non-organic components of a hybrid associate (quantum dye dot) was developed and tested.
- Quantum dot – dye molecule associates were obtained that demonstrate hybrid properties in absorption, luminescence, and nonlinear optical response.

The researchers are currently working on the reduction of the sensitivity threshold of hybrid associates, i.e. they are trying to reduce the response level of the optical density limiter.

Another technology is being developed for coating the surfaces of optical elements with thin films containing hybrid associates of colloid quantum dots and dye molecules that limit optical density.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

- Processing industry enterprises (metal etching and marking, surface quenching, and processing of ultrahard materials).
- Medical institutions for diagnostics and surgery (ophthalmological, oncological, dental).
- Science towns and innovative centres.

### ■ COMMERCIALISATION RISKS

- The complexity of the work could be underestimated and, as a result, the project can fail to be fully implemented.
- Underrated or overrated sales market.



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Andrei Zvyagin,*

assistant at the Department of Optics and Spectroscopy, VSU Faculty of Physics.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

6,000,000.

### ■ SOURCES OF FUNDING

The project is expected to participate in the “Start” programme implemented by the Foundation for Assistance to Small Innovative Businesses in Science and Technology (the Fund for Promotion of Innovations) and receive a grant of 2 million roubles to complete the research and development.

### ■ DURATION OF THE PROJECT

3 years.

### ■ PROJECT PAYBACK TIME

3 years.

### ■ PROJECT PRODUCT

The proposed technology will be used to produce a new generation of biologically compatible antimicrobial protective coatings and polymer films to disinfect various surfaces. The main idea of the project is a unique low-toxic technology used to generate solutions of colloidal nanocrystals of metallic sulphides and their hybrid associates with molecules of organic dyes dispersed in polymers.

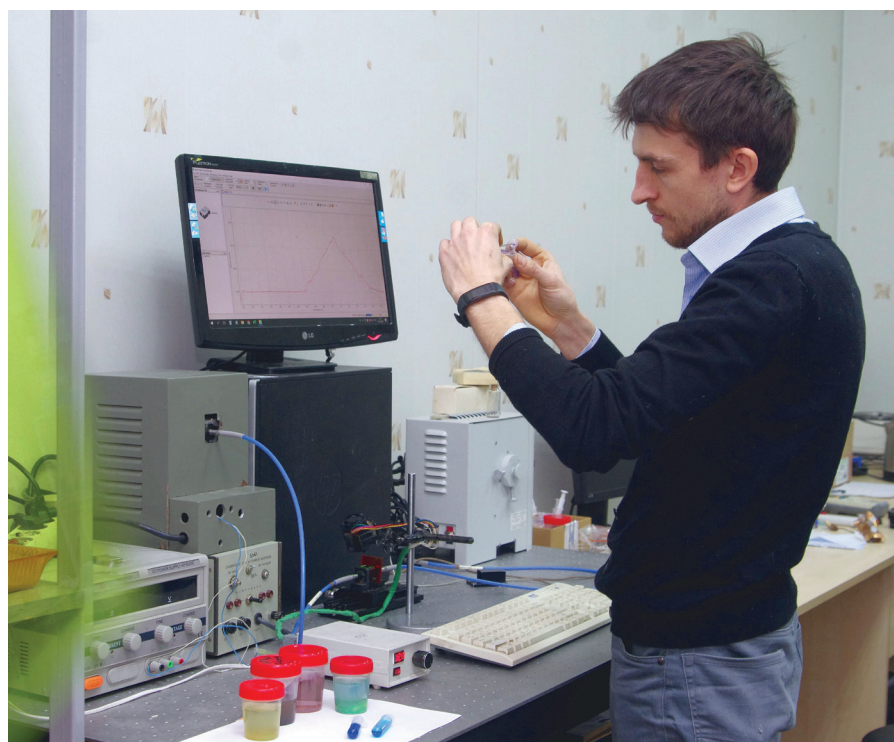
### ■ STAGE OF PROGRESS

Scientific research is being conducted.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The following are expected to be the main consumers of the suggested technology: producers of antibacterial compositions and finishing materials with antibacterial coatings, including those located in the Voronezh Region, as well as medical institutions and pharmaceutical industry companies.

## PHOTOBACTERIUM COATINGS BASED ON METALLIC SULPHIDE NANOPARTICLES AND MOLECULES OF ORGANIC DYES USED TO DISINFECT SURFACES



The main idea of the project is a unique low-toxic technology used to generate solutions of colloidal nanoparticles of  $\text{Ag}_2\text{S}$ ,  $\text{CdS}$ ,  $\text{ZnxCd}_{1-x}\text{S}$ , and their hybrid associates with molecules of organic dyes dispersed in polymers.

The experimental coatings:

- are colloid solutions containing hybrid nanostructures of organic dye molecules (triethylene blue) with nanoparticles of metallic sulphides ( $\text{Ag}_2\text{S}$ ,  $\text{CdS}$ ,  $\text{ZnxCd}_{1-x}\text{S}$ ) with the average size within the range of 1-10 nm and homogeneity within 40 %.
- effectively absorb light within the range of 300-550 nm (which is the range of light absorption by nanoparticles) as well as within the range of absorption of associated dye molecules (500-700 nm).
- luminesce at room temperature within the range of 400-700 nm for nanoparticles  $\text{CdS}$  and  $\text{ZnxCd}_{1-x}\text{S}$  and 800-1200 nm for nanoparticles  $\text{Ag}_2\text{S}$  and luminescence typical for dye molecules (600-700 nm).
- have various ratios of concentrations of nanoparticles and dye molecules.
- have photosensibilisation properties of producing singlet oxygen upon radiant excitation of 350-700 nm.
- show antibacterial effect under optical radiation within the range of 350-700 nm.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Low toxicity of colloidal nanoparticles CdS, ZnxCd1-xS, and Ag<sub>2</sub>S that are being used.
- Hydrophilic nature of colloidal nanoparticles CdS, ZnxCd1-xS, and Ag<sub>2</sub>S that are being used.
- Stabilisation of dye molecules in the form that actively produces singlet oxygen as a result of conjugation with nanoparticles.
- Enhanced antibacterial properties as compared to antibacterial coatings based on separate components, the use of which is known from the reported data.
- A more stable antibacterial effect as compared to common antibiotics.
- No resistivity of bacteria to photobacterium coatings.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Utility model patent No. 134445, Russian Federation, MPK B01 J 13/00, B82 B3/00, B82Y40/00, A unit for synthesis of colloidal semiconductor nanocrystals by means of a low-temperature sol-gel method / O. V. Ovchinnikov, M. S. Smirnov, B. I. Shapiro, T. S. Shatskikh, A. S. Perepelitsa; author and patent holder: Voronezh State University (FSFEI HPE VSU) (RU). — No. 2013127444/05; submitted 17.06.13; published 20.11.13, statement No. 32. — 2 p.
- Invention patent No. 2538262, Russian Federation, MPK C01G 5/00, B01 J 13/00, C09 K 11/02 Method of obtaining semiconductor colloidal silver sulfide quantum dots / O. V. Ovchinnikov, M. S. Smirnov, B. I. Shapiro, T. S. Shatskikh, A. S. Perepelitsa, V. Y. Khokhlov; author and patent holder: Voronezh State University (FSFEI HPE VSU) (RU). — No. 2013127476/05(040933); submitted 17.06.13; published 10.01.15, statement No.1. — 9 p.
- Invention patent No.2540385, Russian Federation, MPK C09K 11/54, C09K 11/56, B82B3/00, B82Y40/00, Method of obtaining semiconductor colloid quantum points of cadmium sulphide / O. V. Ovchinnikov, M. S. Smirnov, B. I. Shapiro, T. S. Shatskikh, A. S. Perepelitsa, A.O. Dedikova; author and patent holder: Voronezh State University (FSFEI HPE VSU) (RU). — No. 2013127477/05; submitted 17.06.13; published 10.02.15, statement No. 4. — 12 p.
- Invention patent No. 2607579, Russian Federation, MPK A61P 35, B82Y5/00, Biocompatible nanomaterial for photosensitivity singlet oxygen and method for production thereof / O. V. Ovchinnikov, M. S. Smirnov, T. S. Shatskikh, B. I. Shapiro, V. N. Popov, V. Yu. Bashmakov, V. Yu. Khokhlov, A. S. Perepelitsa; author and patent holder: Voronezh State University (FSFEI HPE VSU) (RU). — No. 2014141085/20; submitted 10.10.14; published 27.04.2016, statement No. 12. — 14 p.

An invention patent application is now being prepared based on photobacterium properties of the suggested compositions of antimicrobial coatings.

### ■ COMMERCIALISATION RISKS

- Human resources risks.
- Market risks.
- Production risks.
- Financial risks.
- One of the risks is associated with the certification of the product for compliance with sanitary and hygienic requirements.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Alexey S. Perepelitsa,*

PhD in Physics and Mathematics, assistant at the Department of Optics and Spectroscopy of the Faculty of Physics.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

3,000,000.

### ■ DURATION OF THE PROJECT

2018–2020.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

2.5 years.

### ■ SOURCES OF FUNDING

The project is conducted within the framework of the UMNİK programme and is partially supported by the grants of the Russian Foundation for Basic Research.



#### ■ PROJECT PRODUCT

A device for the early non-invasive express diagnostics of the above mentioned mouth cavity pathologies in vivo by means of spectrum analysis instruments: laser-induced fluorescence and reflectance spectroscopy. Additionally, the device can be used to control treatment, photodynamic therapy, photopolymerisation, and dental bleaching.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

Extra-budgetary investments and internal funding will amount to 6,000,000 million roubles within a 3 year period of the project's implementation.

Budgetary investments will amount to 14,000,000 million roubles within a 3 year period of the project's implementation.

#### ■ SOURCES OF FUNDING

- National foundations (Skolkovo, the Fund for Promotion of Small Enterprises in Scientific and Technical Field, grants from the Ministry of Education and Science, etc.).
- Investments from private companies.
- Investments by FSFEI HE VSU.
- Internal financing.

## FIBRE OPTIC DEVICE FOR THE EARLY DIAGNOSTICS OF ORAL CAVITY PATHOLOGIES



One of challenges in dentistry is the early non-invasive diagnostics of the most common tooth pathologies in vivo, i.e. caries, non-cariou diseases, such as wedge-shaped defects, erosion, pathological abrasion of dental hard tissues, etc., dental disorders that started before tooth crowning, including fluorosis, retrognathia, epulis, etc., and other pathologies of the oral mucosa: lichen acuminatus, leukoplasia, etc.

The project is aimed at the development of a device for the early non-invasive express diagnostics of the above mentioned mouth cavity pathologies in vivo by means of spectrum analysis instruments: laser-induced fluorescence and reflectance spectroscopy. Additionally, the device can be used to control treatment, photodynamic therapy, photopolymerisation, and dental bleaching. The key advantages of the medical device in this project are its multifunctionality, reliability, and precision.

#### ■ STAGE OF PROGRESS

A method was developed which can be used to record dental tissue and oral mucosa fluorescence spectrum and diffuse reflection. Algorithms to process recorded spectrum data were developed.

A device prototype was developed which can be used to excite and record fluorescence spectrum and record dental tissue and oral mucosa spectrum reflection.

Dental tissues, both intact and invaded by various pathologies, were studied by means of optical spectroscopy, raster electron microscopy, and XRD microscopy methods.

The obtained results prove that laser-induced fluorescence can be used for early non-invasive in vivo diagnostics of various pathologies of the human oral mucosa.

For the first time it was proved that laser-induced fluorescence can be used to diagnose the early stages of wedge-shaped defects, erosion, fluorosis, and hypoplasia.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The device most similar in functionality and specifications to the proposed device is the DIAGNOdent pen 2190, KaVo (Germany). Nevertheless, this device is, firstly, more expensive, and, secondly, can only be used to treat carious pathologies. The DIAGNOdent pen 2190 cannot be used for treatment control and the diagnosis of non-carious pathologies.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Patented optical circuit proved to be efficient to record a very low dental tissue and oral mucosa fluorescence signal [Patent of the Russian Federation № 2011119146].

### ■ IT IS ALSO PLANNED TO PREPARE AND TO SUBMIT THE FOLLOWING APPLICATIONS FOR INVENTIONS

- Non-invasive non-carious pathology diagnostics device.
- Non-invasive oral mucosa pathology diagnostics device.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Market sectors:

- Geographical: the Russian Federation, Kazakhstan and others, EU countries, Southeast Asia, the USA, etc.
- Product: restorative dentistry and cosmetology.

Potential customers:

- Dental clinics (there are over 80,000 dentists in the Russian Federation [DISCOVERY Research Group]):
- MVK Beauty Line, Dentaljaz, StomArtStudio Leonardo, Dental Mir, OR-TODONT.PRO, Interdent, Virtuoso, Dental City, Kolibri, TARI-DENT, Denti-ka, etc.
- Cosmetological institutions: Bikod, Art-klinik, Beauty Trend, LINKlinik, Best klinik na Krasnoselskoi, etc.



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Dmitry Minakov,*

PhD in Physics and Mathematics, associate professor, researcher at the Fundamental Department of the Faculty of Physics of Voronezh State University.

*Iraida Sarycheva,*

PhD in Physics and Mathematics, associate professor, researcher at the Fundamental Department of the Faculty of Physics of Voronezh State University.

### ■ DURATION OF THE PROJECT

2017 г. по настоящее время.

### ■ PROJECT PAYBACK TIME

4–5 years.

### ■ COMMERCIALISATION RISKS

- Volatility of the currency market and, as a result, increasing prices for optics, fibre optics, spectral equipment, and electronics.
- Overrated sales market.



### ■ PROJECT PRODUCT

Automated measurement systems.

### ■ STAGE OF PROGRESS

The impact of impulse overloads on electronic components was studied. Reversible failures were revealed and experimentally studied. Works were conducted in cooperation with the Ministry of Defence of the Russian Federation.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Automated measurements that can be introduced into a specified production and that will take into account particular features of the production and its products.
- Specified parameters for the assessment of electromagnetic compatibility of electronic and radio equipment components.
- Possibilities to detect ways to improve the process and design parameters of semiconductor devices and electronic components.

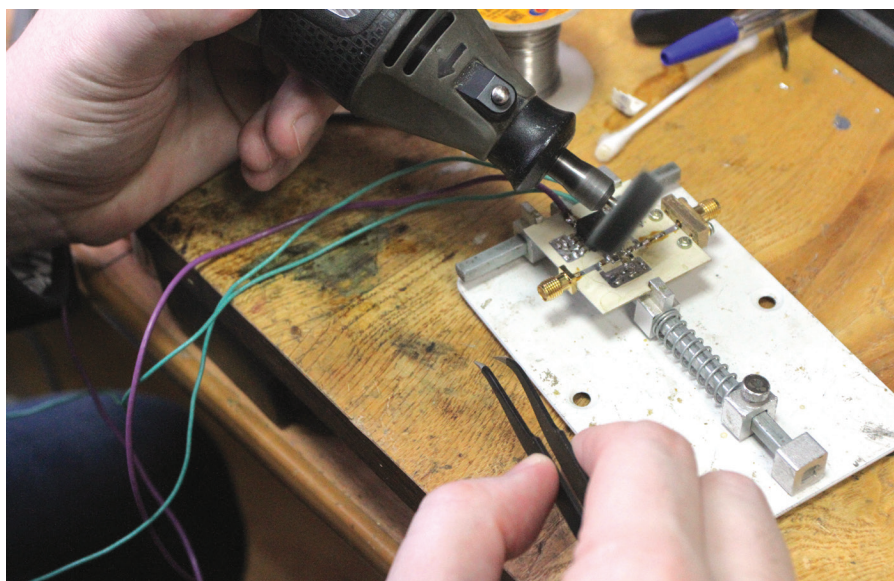
## CREATING AN ENTERPRISE FOR IMPLEMENTING VARIOUS METHODS OF ENHANCING THE RESISTANCE OF ELECTRONIC COMPONENTS TO MODERN AND FUTURE TYPES OF NOISE

The Department of Electronics of Voronezh State University has very deeply rooted traditions, many years of experience in the area of electromagnetic compatibility, and a highly qualified scientific school headed by professor A.M. Bobreshov (Dean of the Faculty of Physics, Head of the Department of Electronics). For the last 10 years, its staff has been conducting intense research into the cofunctioning of ultra-wideband and narrowband radio systems.

For example, methods for the evaluation of ultra-wideband interference on components were developed; research was conducted and attempts to explain physical mechanisms of the interference effect were made.

Major differences between traditional harmonic noise and ultra-wideband interference were determined.

Parameters which consider the physical nature of the effect and which can be used to evaluate the functioning of devices in the ultra-wideband interference environment were determined.



Recommendations were made for the performance optimisation of radio systems aimed at improving their functionality when exposed to interference of various types.

The solution of fundamental and applied problems of resistant functioning of the electronic components in an ultra-wideband interference environment by creating automated measurement systems at radioelectronic enterprises.

Earlier projects were used to develop a method to assess the resistance capacity of the electronic components of electronic equipment to discontinuous ultra-wideband interference. Impulse signals are extremely penetrating and can be dangerous for modern communication systems.



### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

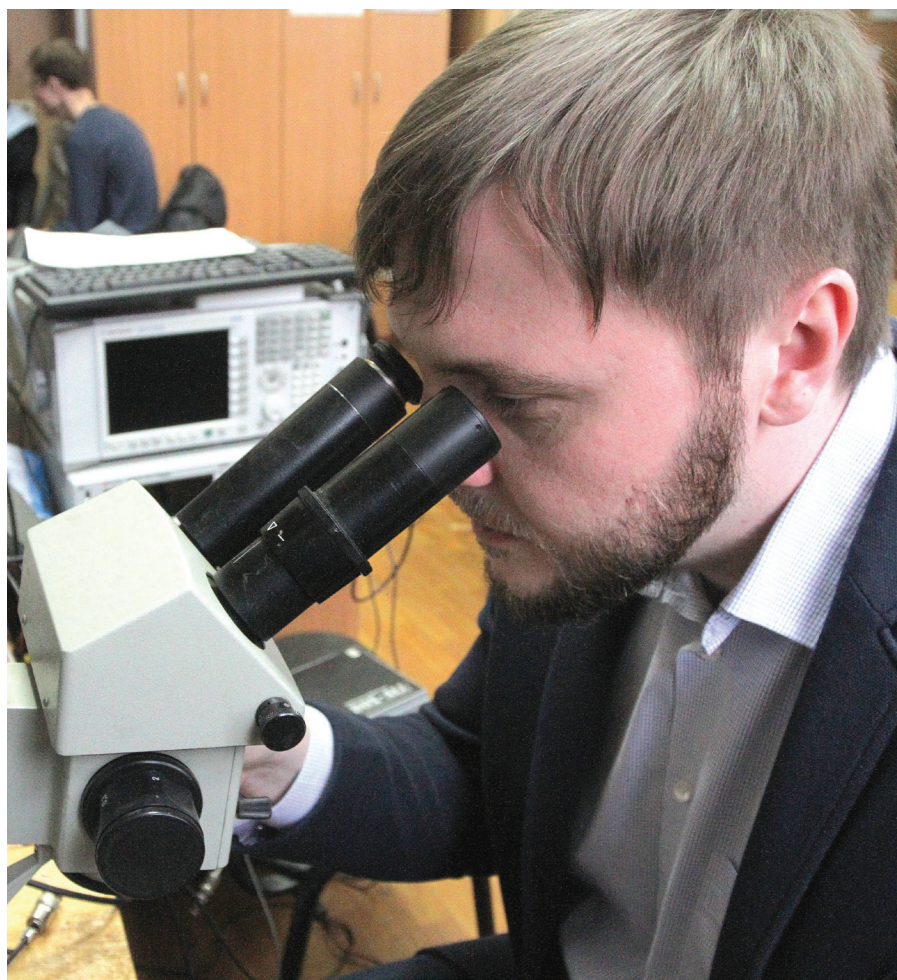
Today, there are about 5–6 companies in Russia which are involved in the introduction of automated solutions and specialise in microelectronics. The estimated market volume is 200–250 million roubles for automated control systems and about 50 million roubles annually for their maintenance. Moreover, there has been a tendency towards increasing production output, the purchase of new production lines and the opening of new factories.

### ■ COMMERCIALISATION RISKS

- Work complexity can be underestimated and, as a result, the project can fail to be fully implemented.
- During the production stage, there is a possibility of supply disruption of components and, as a result, a suspension of production and disruption of production and sales plans.
- Some necessary components can be taken out of production.
- Underrated or overrated sales market.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- A. M. Bobreshov, AIK EMS 3.6.2: Certificate 2013611752 / Voronezh State University; A. M. Bobreshov, I. S. Korovchenko, V. A. Stepkin, G. K. Uskov. – 2013. (№ 2012660891; submitted 11.12.2012; published 20.03.2013).
- A. M. Bobreshov Test module for assessing the resistance capacity of the semiconductor element base of the low-noise microwave band amplifier to high amplitude impulse noise: patent 134667, Russian Federation:
- MPK G01R31/26 / A. M. Bobreshov, I. S. Korovchenko, V. A. Stepkin, G. K. Uskov; author and patent holder: FSFEI HPE VSU – № 2013136406; submitted 05.08.2013; published 20.11.2013. — 13 p.



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Igor Korovchenko,*

PhD in Physics and Mathematics, associate professor at the Department of Electronics of the Faculty of Physics of Voronezh State University.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

6,850,000.

### ■ SOURCES OF FUNDING

The strategic partner in production is AO Concern Sozvezdie.

It is planned to obtain financing from the Foundation for Assistance to Small Innovative Enterprises in Science and Technology, the Skolkovo Foundation, and other sources.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

3.5 years.

### ■ DURATION OF THE PROJECT

2016 г. по настоящее время.

### ■ PROJECT PRODUCT

The proposed unit for the sol-gel synthesis of nano particles with size-dependent optical properties is designed to generate colloidal nanoparticles which can become an effective base for a new generation of products and technologies used to diagnose and treat ontological diseases.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Photostability of generated hybrid associates alongside with sufficient efficiency of singlet oxygen photosensibilisation.
- Initial hydrophilic properties of the produced colloid solution with hybrid associates.
- Low cytotoxicity.
- Biocompatibility.
- Low production cost.
- Possibility to use normalised components and details which can be used simultaneously to solve other tasks.

### ■ DURATION OF THE PROJECT

10 years.

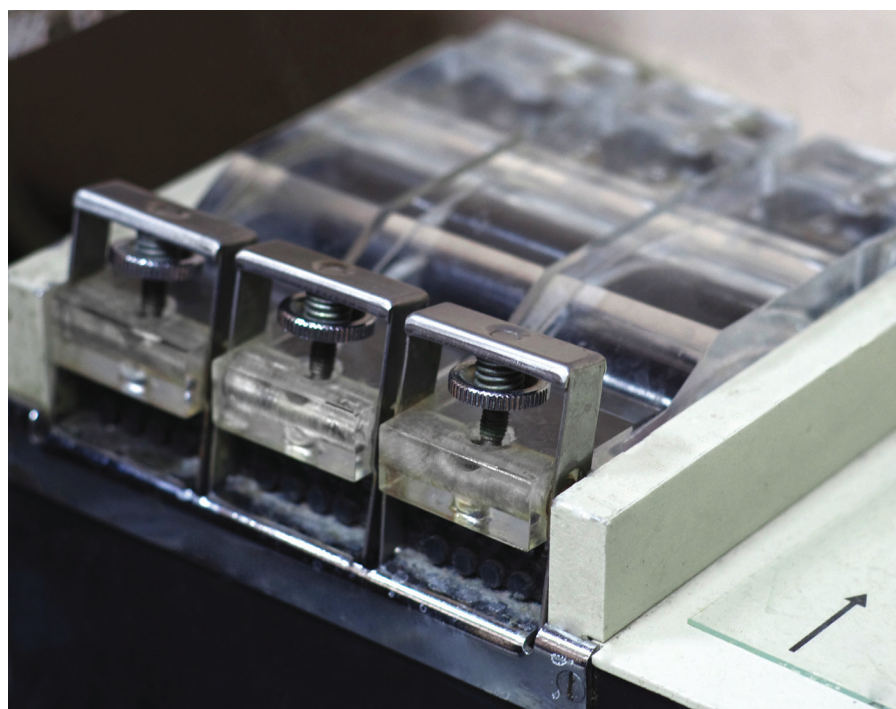
### ■ PROJECT PAYBACK TIME

7.7 years.

## A UNIT FOR THE SOL-GEL SYNTHESIS OF NANOPARTICLES WITH SIZE-DEPENDENT OPTICAL PROPERTIES

This project is aimed at developing a technology and a unit for the synthesis of nano particles with size-dependent optical properties.

A unit for the sol-gel synthesis of Ag<sub>2</sub>S, CdS, CdS/ZnS, ZnxCd<sub>1-x</sub>S colloid quantum dots and their hybrid associates with molecules of organic dyes was developed. The technology enables: 1) to generate hydrophilic gelatinised colloid solution with hybrid associates; 2) at the synthesis stage, to control the size-dependent optical properties of quantum dots to achieve optimal spectral matching of properties of associate's components and to achieve maximum values for singlet oxygen photosensibilisation.



### ■ STAGE OF PROGRESS

A prototype unit for the sol-gel synthesis of nanoparticles with size-dependent optical properties was created at the Department of Optics and Spectroscopy of the Faculty of Physics of Voronezh State University, and a utility model patent of the Russian Federation was received.

Moreover, synthesis methods of colloidal nanoparticles, CdS, CdS/ZnS, ZnxCd<sub>1-x</sub>S, and their hybrid associates with organic molecules of thiazine dyes were developed; a number of patents were received for these methods.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Pharmacological companies, ontological centres, and OOO Science and Technology experimental centre "Nanotekh-Dubna".



## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Utility model patent No. 134445, Russian Federation, MPK V01 J 13/00, B82 B3/00, B82Y40/00, A unit for synthesis of colloidal semiconductor nanocrystals by means of a low-temperature sol-gel method / O. V. Ovchinnikov, M. S. Smirnov, B. I. Shapiro, T. S. Shatskikh, A. S. Perepelitsa; author and patent holder: Voronezh State University (FSFEI HPE VSU) (RU). — № 2013127444/05; submitted 17.06.13; published 20.11.13; statement No. 32. — 2 p.
- Invention patent No. 2538262, Russian Federation, MPK C01G 5/00, B01 J 13/00, C09 K 11/02, Method of obtaining semiconductor colloidal silver sulfide quantum dots / O. V. Ovchinnikov, M. S. Smirnov, B. I. Shapiro, T. S. Shatskikh, A. S. Perepelitsa, V. Y. Khokhlov; author and patent holder: Voronezh State University (FSFEI HPE VSU) (RU). — No. 2013127476/05(040933); submitted 17.06.13; published 10.01.15; statement No. 1. — 9 p.
- Invention patent № 2540385, the Russian Federation, MPK C09K 11/54, C09K 11/56, B82B3 3/00, B82Y40/00, Method of obtaining semiconductor colloid quantum points of cadmium sulphide / O. V. Ovchinnikov, M. S. Smirnov, B. I. Shapiro, T. S. Shatskikh, A. S. Perepelitsa, A. O. Dedikova; author and patent holder: Voronezh State University (FSFEI HPE VSU) (RU). — No. 2013127477/05; submitted 17.06.13; published 10.02.15, statement No. 4. — 12 p.

## ■ COMMERCIALISATION RISKS

- Technical risks. Absence of the required parameters of colloidal nanoparticles ensembles produced by the proposed unit.
- Medical risks. Introduction of biomarkers will cause a strong autoimmune response.
- Commercial risks. The technology cannot be listed in the register of methods of high-technology medical care.



## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

A team from the Department of Optics and Spectroscopy of the Faculty of Physics, head researcher – Oleg Ovchinnikov, head of the Department of Optics and Spectroscopy of the Faculty of Physics, Doctor of Sciences (Physics and Mathematics), professor.

## ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

50,000,000.

## ■ SOURCES OF FUNDING

The prototype was created with the support of the Russian Foundation for Basic Research, the federal target programme, and the grant by the Ministry of Education and Science of the Russian Federation in the framework of the government order to higher education institutions in the sphere of scientific research for 2014-2016.

To conduct further commercialisation of the project, private investment and investment by the venture capital fund OOO Maxwell Biotech Group are expected.



### ■ PROJECT PRODUCT

Technology for the room temperature (23 °C) synthesis of silicon carbide crystal nanophases.

### ■ DURATION OF THE PROJECT

The project is expected to be implemented between 2020 and 2023.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

3 years.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

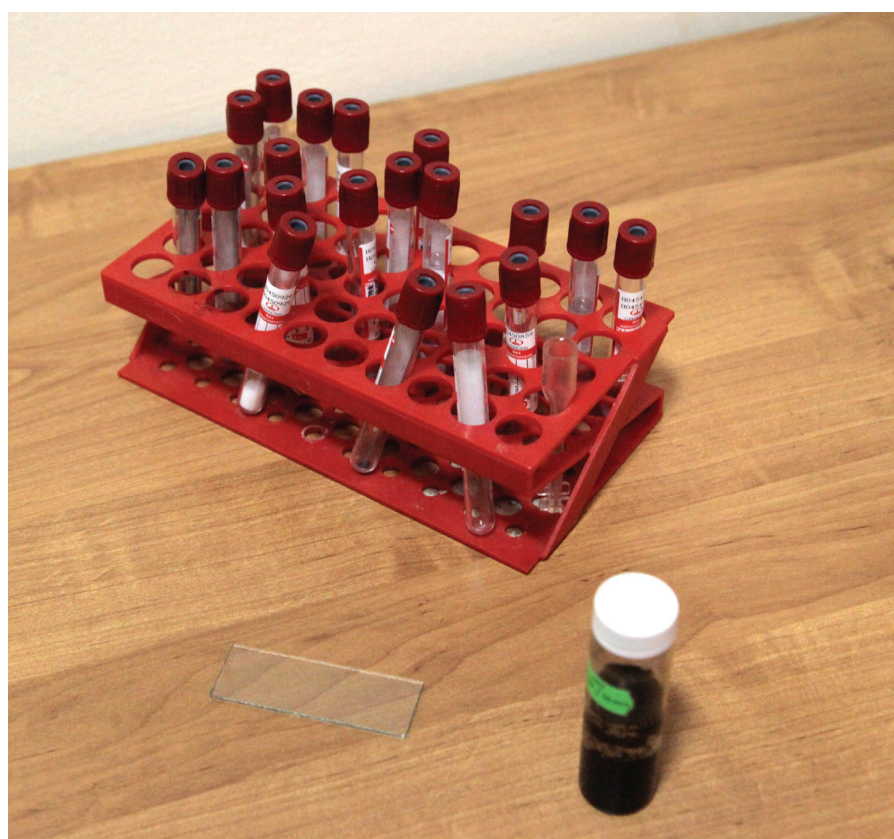
An application for the patent "Production process of nanocomposite materials based on short carbon nanotubes" has been prepared.

## ENERGY-EFFICIENT TECHNOLOGY OF PRODUCING NANOMATERIALS FOR POWER ELECTRONICS

Today, owing to its unique properties, silicon carbide (SiC) is used for various electronic equipment. Silicon carbide has the edge over the classical semiconductor materials, silicon (Si) and gallium arsenide (GaAs), for all important criteria.

Silicon carbide is generated at high temperatures between 1,600 and 2,500 °C. As a result, it involves great energy costs and requires expensive equipment.

The project proposes a whole new energy-efficient method of producing silicon carbide at room temperature which also offers an import substitution solution.



### ■ ADVANTAGES OVER EXISTING ANALOGUES

The closest analogue of the proposed technology is sol-gel technology developed by a research team from Ulyanov Saint Petersburg State Electro-technical University "LETI"

The method proposed by the analogue generates silicon carbide at 700 °C, as compared to the classical technology with a temperature between 1,600 and 2,500 °C.

Our project proposes a unique technology that allows decreasing production costs and generating silicon carbide at room temperature (23 °C).

### ■ STAGE OF PROGRESS

Initial stage. Silicon carbide synthesis was conducted under laboratory conditions. Nanophase silicon carbide was created. Research was carried out using high-precision equipment.

According to the results of the diffractometric analysis, the generated structures have silicon carbide phase, 4-H SiC polytype. The project needs to be continued in the framework of design and experimental works.

### ■ COMMERCIALISATION RISKS

An insufficient number of companies interested in the technology

Solutions:

- To provide information by organising specialised workshops.
- Direct meetings with heads of companies.
- To search for partners on specialised forums.

Insufficient financing

Solutions:

- To prepare and send out sponsorship packages to potential sponsors.
- To submit grant applications and to participate in contests for the funding of innovation projects.
- To cooperate with the administration of Voronezh State University.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The technology is of great importance for electronics producers all over the world. In the Voronezh region, among such companies are: OAO Voronezh Semiconductor Plant, AO Research Institute of Electronic Technology, OAO Design and Engineering Centre "Electronika", and OAO Concern Sozvezdie.



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Dmitry Zhukalin,*

PhD in Physics and Mathematics, associate professor at the Department of Semiconductor Physics and Microelectronics of the Faculty of Physics of Voronezh State University.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

15,000,000 in the first year of the project and 2,000,000 a year in the following years.

### ■ SOURCES OF FUNDING

Grant of the Russian Foundation for Basic Research 16-43-360281 "Physical and chemical foundations the low-temperature synthesis of silicon-carbide nanostructures for electronic components used in extreme electronics".

Applications for financial support of the project are being prepared or were submitted to a number of Russian foundations; negotiations are conducted with companies who have offered support to other research projects.

### ■ PROJECT PRODUCT

Integrated compact device that uses dielectric spectroscopy to measure the size of colloidal particles of 20 nm and more with total weight of particles from several mg. In case of polydisperse colloids, the device enables recapturing the function of particles size distribution in a wide range of particles concentrations in the colloid solution.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

OOO PlazmoSil, Alexandr Lazarev, general director.

### ■ DURATION OF THE PROJECT

2 years.

### ■ PROJECT PAYBACK TIME

3 years.

### ■ COMMERCIALISATION RISKS

- Environmental.
- Marketing.
- Technical.
- Legal.
- Commercial.
- Financial.

## DEVELOPMENT OF A COLLOIDAL PARTICLE SIZE ANALYSER BASED ON THE METHOD OF DIELECTRIC SPECTROSCOPY

Today, DLS-spectroscopy is used to measure colloidal particles.

The goal of this project is to create a dielectric spectroscopy measurement system which allows not only inexpensive and efficient measurements but also statistical distribution of studied dispersions along particle sizes.

### ■ STAGE OF PROGRESS

Technical requirements for the colloidal particle size analyser based on the method of dielectric spectroscopy were developed; programmes and test methods for prototype models of the colloid particles size distribution analyser were developed.

Prototype models of the colloid particles size distribution analyser were created. Laboratory testing of prototype models of the device were carried out to adjust characteristics for further commercialisation.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- The device allows recapturing the function of particle size distribution.
- It is compact and easy to operate.
- It is more reliable.
- It is cheaper.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

EFKO Group of Companies, OOO Laska, and the Skolkovo Foundation.



### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Computer program "Colloid KEF-16" № 2016619081 dated 12.08.2016.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

10,000,000.

### ■ SOURCES OF FUNDING

Grants, subsidies, internal funds, attracted funding.

"The Fund for Promotion of Small Enterprises in Scientific and Technical Field" – contract No. 11991P/21889 dated 27 June 2013, No. 359 GS2/21889 dated 01 April 2015, with total amount of 3 million roubles.

An investment contract was signed with OOO Laska in the amount of 2 million roubles and with OOO Polimer-V in the amount of 4 million roubles.



## DESIGN AND PRODUCTION OF SKIN CARE PRODUCTS TAKING INTO ACCOUNT THE CHARACTERISTICS OF CUSTOMERS' SKIN AND THEIR ORGANILEPTIC PREFERENCES

Our planned service has no analogues anywhere in the world. A team of researchers from Great Britain, the Czech Republic, and Voronezh State University developed a unique technology for manufacturing client-oriented cosmetic products. The technology takes into account a customer's personal characteristics and their skin type, as well as the allergic potential and biocompatibility of cosmetic ingredients.

Our products do not contain any synthetic ingredients, fragrances, or preservatives. They are completely natural.

### ■ STAGE OF PROGRESS

The promo version of the project was launched in April 2020. The key audience are customers in Voronezh and the Voronezh Region. Later the product will be promoted in other large cities in Russia and abroad.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

There are no analogues.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Know-how. Certain methods and stages can be patented, but, unfortunately, not the basic principle.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

A B2C service. May be interesting to investment funds.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

2 million roubles during the first year will be enough. However, 20 million roubles will give the project a much greater boost.

### ■ SOURCES OF FUNDING

Internal financing, reinvestment of profits. We are currently searching for investors.

### ■ COMMERCIALISATION RISKS

There are no commercialisation risks in the cosmetics industry.

### ■ PROJECT PRODUCT

We developed the technology and a website for the design and production of personalised cosmetic products.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

The projects initiators and developers are members of a VSU-based small innovative business OOO Institute of System Biotechnologies. [www.gialika.ru](http://www.gialika.ru)

### ■ DURATION OF THE PROJECT, РУБ.

The project may become global and demonstrate exponential growth. The project's potential is compatible to that of a pharmacy chain and/ or a fast food chain, but without any competitors during the early years.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА, РУБ.

6 months.

### ■ PROJECT PRODUCT

Supersorbent beads.

### ■ STAGE OF PROGRESS

Refining the methodology of supersorbent synthesis and designing an advanced production unit.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

3 years.

### ■ DURATION OF THE PROJECT

1.5 years.

## FULL-TIME HI-TECH PRODUCTION OF INNOVATIVE WATER-RETAINING SUPERSORBENT SOLID WATER

Solid Water is a polymer, whose beads are sown in a field. The field is then watered. The polymers absorb water and function as automated reservoirs that maintain the humidity level in the soil. When the humidity level becomes lower, the beads release the water gradually so that it can get to the roots of the plants. When it rains, or the field is watered, they absorb water again.

This absorption-release cycle can repeat many times. 1 kg of the supersorbent absorbs up to 500 litres of water from the soil. It could be enough to fill polymer with water once in a year, and thus, even during dry periods agricultural plants will keep growing. Once sown in the field, the sorbent will function properly for 10 years.



Various micro- and macroelements can also be added to the sorbent, thus transforming it into an organic fertilizer.

The project has been conducted for 4 years using advanced equipment provided by Voronezh State University. The project is conducted jointly with Voronezh State Agricultural University.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The substrate proposed is an import-substituting solution. Solid water is cheaper than its foreign analogues.

The main advantage is that the technology is adapted to Russian climate and the beads are frost-resistant. Solid Water also has certain benefits for the environment as it improves the structure of the soil, and does not pollute or swamp it. When the beads' lifespan is finished, they dissolve into non-toxic components. The advantage of the production method of Solid Water is that it uses industrial chemical agents and simple equipment that does not require great expenditure.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Patent of the Russian Federation No. 2574722 Date of issue: 09.12.14. "Method for obtaining hydrophilic cross-linked polymer with super-sorbent properties". Published 10.02.2016. Statement No. 4. Authors: V. A. Kuznetsov, V. F. Selemenev, V. N. Semenov, M. V. Bakalova.
- Patent application No.2016110329 dated 21.03.2016. "Method for producing superabsorbent containing microelements". Authors: V. A. Kuznetsov, I. V. Ostankova, V. F. Selemenev, V. N. Semenov, A. V. Zenischeva, A. L. Lukin, M. S. Lavlinskaya, A. N. Kharin.
- Patent application No.2016110329 dated 21.03.2016. "Method for obtaining water absorbing composite polymer material". Authors: V. A. Kuznetsov, V. F. Selemenev, V. N. Semenov, A. L. Lukin, I. V. Ostankova, M. S. Lavlinskaya, A. V. Zenischeva.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

- Agricultural companies
- Farms
- Fertilizer distribution centres.

### ■ COMMERCIALISATION RISKS

- Lack of financing to purchase equipment
- Intellectual property theft
- Equipment failure
- Increase in price of raw materials, energy, and water supply.



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Vyacheslav Kuznetsov,*

DSc in Chemistry, Professor at the Department of High Molecular Compounds and Colloids of VSU.

*Vladimir Selemenev,*

DSc in Chemistry, Professor, Head of the Department of Analytical Chemistry of VSU, Honoured Scientist of the Russian Federation.

*Viktor Semenov,*

DSc in Chemistry, Professor at the Department of General and Inorganic Chemistry, Dean of the Faculty of Chemistry of VSU.

*Alexey Lukin,*

DSc in Agriculture, Professor at Voronezh State Agricultural University..

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

30,000,000.

### ■ SOURCES OF FUNDING

University budget.



### ■ PROJECT PRODUCT

A reagent kit for the allele-specific PCR for the detection of mutations associated with increased risk of breast cancer, and a software package for the analysis and export of the results.

### ■ STAGE OF PROGRESS:

A working prototype was manufactured.

### ■ DURATION OF THE PROJECT

2017–2022.

### ■ PROJECT PAYBACK PERIOD

2025

## AN INNOVATIVE TEST SYSTEM FOR THE EARLY DIAGNOSIS OF A PREDISPOSITION TO BREAST CANCER “ONKOPRIME I”

The test system performs the early diagnosis of predisposition to breast cancer based on the analysis of DNA polymorphisms (mutations) by means of allele-specific PCR. The preliminary research demonstrated that the mutations most commonly analysed in clinical practice in Russia are not associated with an increased risk of breast cancer. It also demonstrated that some other polymorphisms are common among populations and can be used as a predictive tool for assessing the risk of breast cancer. We are currently testing the clinical relevance of these mutations at the Budgetary Health Care Institution of the Voronezh Region Voronezh Region Clinical Oncology Centre. We are also conducting design and experimental works in order to produce a working prototype of the test system and develop a methodology for the processing of the results using special software.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Low production cost. Due to the low production cost of the test kits and the resulting low cost of a test per patient, healthcare institutions will be able to set a lower price for the test.
- High availability. Lower production cost will result in lower prices, and thus will make the test system available to a larger number of patients.
- Low equipment requirements. The test system is based on the allele-specific PCR and does not require any other equipment. Most clinical diagnostics laboratories already have the PCR amplification kits that are necessary to perform the test.
- Social and economic benefits. Lower price and higher availability of the test will result in better treatment of breast cancer due to its early diagnosis and the corresponding increase in the effectiveness of the therapeutic measures.
- Automated results processing. The results of the test are analysed by means of special software which reduces the influence of the human factor on the accuracy and quality of the results.
- Integration with the HIS of the healthcare institution. The system’s software will enhance the transfer of the test results from the machine to the database storing the results of the tests.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

We filed an application for an invention patent (application No. 2018142623 dated 03.12.2018 “A method for the diagnostics of predisposition to breast cancer in the Russian population based on PCR-RFLP”, Russian Federation). The application is now under review.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

- Healthcare institutions (both private and public) that perform clinical diagnostics: OOO INVITRO, OOO Klinika Gorod Zdoroviya, OOO Medexpert, OOO CentrMolekularnoi diagnostiki, ZAO Medical Genomics, etc.
- Large research centres performing experimental cancer treatments: N. N. Blokhin National Medical Research Centre of Oncology, National Medical Radiology Research Centre of the Ministry of Health of the Russian Federation, and N. N. Petrov Research Institute of Oncology.
- Research and education institutions performing pilot and screening studies.

### ■ COMMERCIALISATION RISKS

Commercialisation risks are associated with the demand for the product, since the cost of the test is not covered by either compulsory or supplementary health insurance and patients have to pay for the test themselves. However, a well-organised promotion campaign, primarily among the employees of healthcare institutions who should be made interested in using the product, can facilitate the successful introduction and effective use of the product.

As to the EU and the USA, the main risk is the necessity of additional clinical trials and the need to obtain approval by local regulatory agencies (FDA in the USA, and MHRA in the EU).



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Sergei A. Solodskikh,*

research assistant at the Department of Genetics, Cytology, and Bioengineering of Voronezh State University.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

12,000,000.

### ■ SOURCES OF FUNDING

R&D grant of the Federal Target Programme "Research and development in top-priority areas of science and technology in Russia for 2014–2020". We also plan on receiving extra funding in the framework of the START programme. The project received a prize from the Innovation Cup 2020 competition.

### ■ PROJECT PRODUCT

Bumblebee breeding technologies. Consumable products for bumblebee farms and greenhouse facilities which use bumblebees (food, medicine, etc.). R&D service.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The only large laboratory for developing bumblebee and solitary bee breeding technologies in Russia that does not belong to large bumblebee producers.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Every bumblebee farm in Russia.

### ■ COMMERCIALISATION RISKS

Decline in production by Russian bumblebee farms – the key consumers of the product.

## DEVELOPMENT OF UNIQUE EQUIPMENT AND THE MANUFACTURE OF CONSUMABLE PRODUCTS FOR BUMBLEBEE FARMS AND GREENHOUSE FACILITIES

There are four specialised bumblebee farms, two greenhouse facility-based bumblebee laboratories, and a single enterprise OOO Tekhnologii Shmelevodstva, that develop unique technologies, equipment, and consumable products for bumblebee farms in Russia.

The technological gap between the leading bumblebee enterprises in Russia and most international companies has been practically eliminated thanks to the introduction of technologies developed by OOO Tekhnologii Shmelevodstva.

The development and introduction of new bumblebee breeding technologies can significantly reduce the cost of plant pollination by bumblebees.

This can very much help in ensuring a stable growth in the output of greenhouse vegetables in Russia. Local production of irreplaceable consumables for greenhouse facilities is a key component of a state's food safety. Such consumables include bumblebees and consumable products - food, medicine, etc. The target consumers of the project are bumblebee farms in Russia. Since 2019, we have been working on a technology for breeding and using mason bees for plant pollination in greenhouses and on open land.

The products were developed, produced, and introduced by VSU researchers.





## ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

3,500,000.

## ■ SOURCES OF FUNDING

- State support subsidies to small innovative enterprises - 500,000 roubles, as grants obtained from Department of Industry, Department of Transport, and Department of Innovations of the Voronezh Region.
- R&D grant for solving various problems in Voronezh. Voronezh administration, Mikhail Yu. Syromyatnikov - 100,000 roubles.
- "U.M.N.I.K." programme grant — 270,000 roubles.
- Innovation Technology Business competition prize granted in 2011 – 20,000 roubles.
- Innovation Technology Business competition prize granted in 2013 by Angstrom furniture production group - 20,000 roubles.
- Subsidies from Voronezh budget granted to partly compensate for the expenditures of the small innovative business - 308,605 roubles.
- Internal financing, including profit reinvestment.

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Know-how 102010000000029. A technology for preparing protein feed with a pollen substitute. License agreement No. 2/11 dated 11 October 2011. Accounting statement No. 381. License agreement No. 2/11 granting the right to use the results of intellectual activity.
- A. V. Lopatin, M. Yu. Syromyatnikov Method of controlling pollination of cucumber flowers by bumblebees and honey bees // Invention patent No. 2485767. Application No. 062743. Project No. 2011141922/13(062743). Priority of the invention dated 18.10.2011. The patent was granted on 5 February 2013. Registered in the state register of the Russian Federation on 27.6.2013. Patent holder - OOO Tekhnologii Shmelevodstva
- A.V. Lopatin, M.Yu. Syromyatnikov, G.K. Uskov, V.N. Popov A device for stimulation of bumblebee colonies development // Utility model patent No. 132947. Project No. 2013104015/13(005852). Priority of the utility model registered on 31.01.2013. The patent was granted on 15 March 2013. Registered in the state register of the Russian Federation on 10.10.2013. Patent holder - OOO Tekhnologii Shmelevodstva
- A.V. Lopatin, M.Yu. Syromyatnikov, D.V. Vostrikov, D.M. Gerasomiv, V.N. Popov A rearing cage for bumblebees, insects, and mites bred to protect plants from pests // Utility model patent No. 136683. Application No. 031385. Project No. 2013121285. Priority of the utility model registered on 13.05.2013. Registered in the state utility models register of the Russian Federation on 20.01.2014. Patent-holders - OOO Tekhnologii Shmelevodstva, FSFEI HPE VSU.
- A.V. Lopatin, M.Yu. Syromyatnikov, G.K. Uskov, V.N. Popov A method for the evaluation of the toxicity and nutritional value of feed for bumblebees and bees, bee-keeping products, and other food products based on artificial bumblebee microcolonies // Invention patent No. 2670448. Registered in the state utility models register of the Russian Federation on 20.01.2014. Application: Application No. 056587. Project No. 2016136035. Date of issue: 06.09.2016. Patent-holders - OOO Tekhnologii Shmelevodstva, FSFEI HPE VSU.

## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

VSU-based small innovative enterprise OOO Tekhnologii Shmelevodstva and its CEO Alexey Lopatin, PhD in Biology, head researcher at the "Venevitinovo" Educational and Research Biocentre.

## ■ DURATION OF THE PROJECT

2011 г. по настоящее время.

## ■ PROJECT PAYBACK TIME

2017.

## ■ STAGE OF PROGRESS

The project resulted in the development of a unique hi-tech knowledge-intensive production of equipment and consumable products for bumblebee farms and greenhouse facilities which use bumblebees.

### ■ PROJECT PRODUCT

MRI contrast agent based on stealth liposomes.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The suggested MRI contrast agent based on magnetic liposomes with magnetite nanoparticles is highly advantageous compared to the traditional chelated gadolinium complexes.

### ■ COMMERCIALISATION RISKS

- Research and technical risks
- Production risks
- Market risks
- Financial risks
- Human resources risks.

## MRI CONTRAST AGENT LIPOCSAN

MRI contrast agents enhance the diagnostic capability of MRI and are used to determine the size of the tumour and improve the visibility of its internal body structures. They also help to identify metastases with more accuracy. Gadolinium(III) containing MRI contrast agents are some of the most commonly used. Being quite effective, gadolinium(III), however, is also highly toxic.

The suggested MRI contrast agent is based on nanostructured magnetite which is incorporated into stealth liposomes. It is not toxic and helps to reduce the probability of side effects and allergic reactions.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Patent research on “Development and production of the product. Patent research. Content requirements and procedure” was carried out in accordance with the requirements of GOST R 15.011-96.



The researchers working on the project also registered an invention patent (application No. RF2015147397 submitted 3 November, 2015) “Production of liposomes” (patent No. RU2621145 registered by V. G. Artyukhov, I. A. Koltakov, and E. V. Shilova).

While conducting the R&D project for the production of the Lipocsan MRI contrast agent, the researchers also developed new methods of production and processing of nanostructured magnetite as well as new methods for incorporating nanostructured magnetite into liposomes. It is therefore possible to submit applications for the registration of the intellectual property rights for the obtained samples and developed methods.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

- Leading medical centres and research laboratories in Voronezh and the Central Black Earth Region
- State and private diagnostic centres with MRI equipment
- Leading pharmaceutical companies that promote new products on European and global markets

Major consumers in the Voronezh Region will be the following:

- Voronezh Regional Clinical Diagnostic Centre
- Interregional centre for the early diagnostics and treatment of oncology diseases
- Voronezh regional children's clinical hospital
- Diagnostic and treatment centre of the International Institute of Biological Systems
- Chernozemiye medical centre
- MRI Expert

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

20,000,000.

### ■ SOURCES OF FUNDING

- 2018-2020 - FTP "Research and Development in Top-Priority Areas of Science and Technology in Russia for 2014-2020", activity 1.3 "Applied research aimed at developing new products and technologies".
- 2019 - financing from the Fund for Promotion of Innovations for the completion of the project and preclinical trial of the produced agent (Start 1 programme).
- 2020 - it is planned to continue cooperation with the Fund for Promotion of Innovations and obtain financing for the development of full-scale production of the suggested agent.
- It is also planned to obtain financing from the Fund for Promotion of Innovations within the Start 2 programme provided that the project will be co-financed from VSU's internal funds.
- Internal financing.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Igor Koltakov,*

Associate Professor at the Department of Biophysics and Biotechnology of the Faculty of Medicine and Biology

### ■ DURATION OF THE PROJECT

2018–2027.

### ■ PROJECT PAYBACK TIME

6 years.

### ■ STAGE OF PROGRESS

Final stage of the R&D project.





### ■ PROJECT PRODUCT

Predator mites - biological plant protection agents.



### ■ ADVANTAGES OVER EXISTING ANALOGUES

Either there are no analogues in Russia with similar functions or they are produced in small quantities. Advantages over existing foreign analogues: lower price and higher viability of mites due to shorter delivery time.

### ■ STAGE OF PROGRESS

First import-substituting production of pest-free *Phytoseiulus* predator mites, predator *Amblyseius swirskii* mites, and *Neoseiulus cucumeris* mites was created.

## DEVELOPMENT OF BIOTECHNOLOGIES FOR PLANT PROTECTION FROM PESTS AND VERMIN IN GREENHOUSES



Predatory insects and mites are widely used for pest management of plants in greenhouses. Biological plant protection helps to fight pests which are resistant to pesticides, and thus cut down on the use of toxins and get ecologically clean products.

However, there is a lack of specialised industries producing the most popular biological control agents. To meet the demand, it is necessary either to import these agents or to produce them in the in-plant laboratories. The foreign importers present on the market are Biobest (Belgium), BioBee (Israel), and Koppert (Netherlands).

In 2019, the total area occupied by greenhouses in Russia exceeded 2.5 thousand hectares, and the demand for biological control agents amounts to about 1,000 million roubles. The target consumers of the project are national greenhouses. The project is aimed at developing the production of import-substituting predator mites for greenhouse facilities.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- A. V. Lopatin, M. Yu. Syromyatnikov, D. V. Vostrikov, D. M. Gerasomiv, V. N. Popov A rearing cage for bumblebees, insects, and mites bred to protect plants from pests // Utility model patent No. 136683. Application No. 031385. Project No. 2013121285. Priority of the utility model registered on 13.05.2013. Registered in the state utility models register of

the Russian Federation on 20.01.2014. Patent-holders - OOO Tekhnologii Shmelevodstva, FSFEI HPE VSU.

- A. V. Lopatin, M. Yu. Syromyatnikov, D. V. Vostrikov, D. M. Gerasomiv, V. N. Popov Multicomponent substrate for storage and transportation of agents of biological protection of plants and also other small animals // Invention patent No. 2659830. Registered in the state utility models register of the Russian Federation on 20.01.2014. Project No. 2016135833. Priority of the invention dated 18.10.2011. Patent-holders - OOO Tekhnologii Shmelevodstva, FSFEI HPE VSU.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

150,000,000.

#### ■ SOURCES OF FUNDING

- Grant obtained within the Start 13 H5 programme of the Foundation for Assistance to Small Innovative Enterprises in Science and Technology - 1,000,000 roubles. Application No. 13-1-H5.7-0189-1-C. Contract No. 12067p/22848 dated 25.07.2013. Project title - Development of biotechnologies for cucumber pollination by bumblebees and the control of bumblebees based on devices for stimulating colony initiation, as well as improvement of the laboratory methods of breeding Phytoseiulus predator mites. Federal State-Funded Educational Institution "Foundation for Assistance to Small Innovative Enterprises in Science and Technology".
- Grant for an innovative project implementation "Development of biotechnologies of plant pollination and protection in greenhouse facilities" provided by the Voronezh Region Economic Development Department - 1,000,000 roubles. Contract No. 7/B dated of 16.12.2013.
- Subsidies from the budget of the Voronezh Region for promoting university-based small innovative enterprises focusing on the practical application of the results of intellectual activity for the project "Biotechnologies of agricultural plant pollination and protection by means of beneficial insects and mites" - 800,000 roubles. Agreement No. 1 dated 09.11.2018.



#### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

VSU-based small innovative enterprise OOO Tekhnologii Shmelevodstva and its CEO Alexey Lopatin, PhD in Biology, head researcher at the "Venevitinovo" Educational and Research Biocentre.

#### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Greenhouse facilities in Russia.

#### ■ COMMERCIALISATION RISKS

New competitors. Decline in production by Russian greenhouse facilities due to lower prices on imported goods.

#### ■ DURATION OF THE PROJECT

2013-2025.

#### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

2025.



**■ PROJECT PRODUCT**

A database comprising DNA cytochrome c oxidase genes for various species and their genetic markers. Biomaterial taxonomy identification services.

**■ DURATION OF THE PROJECT**

3 years.

**■ PROJECT PAYBACK TIME**

2 years.

**■ COMMERCIALISATION RISKS**

- Technological.
- Commercial.

## DEVELOPMENT OF THE GENETIC IDENTIFICATION METHOD OF BIOMATERIAL TAXONOMY, BASED ON DNA BARCODING

The aim of the project is to create a laboratory where taxonomy identification will be performed at any stage of development with no regard to the gender of the organism. The method presupposes the decoding of a certain DNA segment of the organism and its comparison to the results presented in international databases. As a barcode, a cytochrome c oxidase subunit 1 gene of a mitochondrial DNA is used for animals, ITS is used for fungi, and *rbcl* and *matK* are used for plants. Markers of this sequence will include nested PCR, TaqMan probes, molecular beacon probes, etc.

**■ ADVANTAGES OVER EXISTING ANALOGUES**

The proposed identification method is an innovative one. The key difference of the proposed method from the existing foreign analogues is that we are going to develop an information system compiling a set of genetic markers for each insect species. This will result in lower production costs and will allow agricultural enterprises to simultaneously identify the taxonomy of a large number of insects belonging to different groups.





#### ■ STAGE OF PROGRESS

The project is now in its final stage. The proposed analysis method was tested on organisms from various taxonomic groups, and their sequenced sequences were registered in the GenBank system.

#### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- “Method for differentiation of commercially important mites of *Amblyseius* genus based on restrictive analysis”.
- “Method for identification of *Eurygaster integriceps* based on restriction analysis of cytochrome c oxidase subunit 1 gene of a mitochondrial DNA”.

#### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Prospective consumers of the product may include various research institutes, supervision bodies (Federal Service for Veterinary and Phytosanitary Surveillance, Federal Service on Customers' Rights Protection and Human Well-being Surveillance, etc.), quarantine service, customs bodies, farms, and agricultural organisations, in particular, ZAO Verofarm, and ZAO Molvest.



#### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Anastasia Kokina,*

Lecturer, PhD student of the Department of Genetics, Cytology, and Bioengineering of the Faculty of Medicine and Biology of VSU.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

5,000,000.

#### ■ SOURCES OF FUNDING

To finish the research within this project it is necessary to obtain grants from the Russian Foundation for Basic Research, federal target programmes, etc., and/or Bortnik Fund financing.

### PROJECT PRODUCT

Young plants of common oak; methodology of quickened growth of trees and hardy-shrub plants.



### STAGE OF PROGRESS

Search for investors.

### СРОК ОКУПАЕМОСТИ ПРОЕКТА

2 years.

### DURATION OF THE PROJECT

1 year.

## DEVELOPMENT OF THE TECHNOLOGY OF THE COMMON OAK (QUERCUS ROBUR L.) QUICKENED GROWTH FOR THE REAFFORESTATION OF THE CENTRAL BLACK EARTH REGION

Introduction of technology of the quickened growth of the common oak (*Quercus robur* L.) helps to solve some of the most urgent environmental and industrial problems of the Central Black Earth Region on federal, regional, and municipal levels.

As a result of many years of research, a technology for the quickened growth of the common oak (*Quercus robur* L.) was developed. Various types of mixed soil were tested that quicken the growth of the common oak. The mixtures include peat, silt, humus, and various amounts of fertilizers. It takes a year to grow young plants to a usable size, when they have strong rootstocks and enough leaves for photosynthesis.

If the technology is introduced into full-scale production, 150,000 young plants will be grown every year.



### ADVANTAGES OVER EXISTING ANALOGUES

- Shorter growth time.
- Using silt, which helps to solve the problem of waste disposal.
- Lower production cost.
- Using local soils.
- Year-round production.
- Large target market.



### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Two patent applications are ready to be submitted to the Federal service for intellectual property, patents, and trademarks. A patent in a similar area was registered (No. 2498968, Russian Federation, IPC C05F5/00, C05F3/00. Method of use of wastes of oil-extraction production as fertiliser for growing tomatoes in black soil / T. A. Devyatova, K. Yu. Tolkalina, V. N. Kalaev, A. A. Voronin.: applicants and patent holders: Federal State-Funded Educational Institution of Higher Professional Education "Voronezh State University" (FSFEI HPE "VSU"). - 2012112005/13; submitted 29.03.2012; published 20.11.13, statement No. 32. – 8.).

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

There are several groups of potential consumers.

- Participants of federal reforestation programmes
- Lessees of forest areas
- Agricultural enterprises and groups
- Land and estate owners

Technologies for the quickened growth of forest trees that can be employed for large-scale city landscaping, are now being developed. Some of these technologies are aimed at growing rare ornamental trees and shrubs widely used by landscape designers and gardeners (Phododendron L., in particular).

### ■ COMMERCIALISATION RISKS

- Failure of the heating system of the greenhouse facility in winter
- Plants being infected by diseases and pests
- Failure to reach the planned turnover
- Lower sale price as compared to the planned one



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Evgeniya Moiseeva,*

PhD in Biology, lecturer at the Department of Ecology and Land Resources of the Faculty of Medicine and Biology and senior research fellow at the B.M. Kozo-Polyansky Botanical Garden of Voronezh State University.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

1,850,000.

### ■ SOURCES OF FUNDING

External investors (including state institutions) interested in the implementation of the project. The project may also be interesting to owners or lessees of forest areas that need reforestation.



### ■ PROJECT PRODUCT

Ion-exchange membranes of the new generation and electro dialysis machines employing these membranes.

### ■ DURATION OF THE PROJECT

2 years.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

5 years. This time may be shorter if the number of orders is large enough.

### ■ COMMERCIALISATION RISKS

Limited financial means of the customers. It may prove to be impossible to reach the technology effectiveness level required by the customer. The quality of bipolar ion-exchange membranes produced by OOO Innovative Enterprise Shchekinoazot needs to be increased.

Introduction of new types of bipolar membranes may result in higher production cost.

## PRODUCTION OF ION-EXCHANGE MEMBRANES AND ELECTRODIALYSIS MACHINES EMPLOYING THESE MEMBRANES



Ion-exchange membranes are used in electro dialysis machines for filtering, separating and concentrating of substances. Electro dialysis technologies offer a scalable system that can be used to solve various problems, such as industrial sewage disposal, synthesis and production of food and pharmaceutical products, as well as production of ultra pure water for thermal power stations, nuclear power stations, and the electronics industry. It is also possible to regenerate acids and bases from salts, as well as from galvanic and industrial sewage. Acid and base production units employ bipolar membranes.

The project's stages include the modification of existing types of ion-exchange membranes, development of new membranes, as well as the design and testing of electro dialysis machines.

As a result of the project, technological solutions for production of ion-exchange membranes, electro dialysis machines, and automation and control systems will be developed, and laboratory and experimental-industrial electro dialysis machines will be tested in conditions which are as close as possible to those of real-life production.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The major advantage of the proposed system is that the results were introduced and tested at real economic sector enterprises. The project offers advanced scalable methods of ion-exchange membranes production applicable to manufacturing conditions in Russia. Research in the area of bipolar membrane production resulted in a highly demanded specific product. Most of the patented methods of bipolar membrane production are rather complicated, not flexible enough, and hence, difficult to implement.

The proposed ion-exchange membranes may be used to produce highly competitive import-substituting electrodeionisation machines for ultrapure water production.

#### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Electrodialysis technologies are widely used in nuclear industry, as well as food, pharmaceutical, and chemical industries.

The project is conducted jointly with AO Hidrogas, OOO Innovative Enterprise Shchekinoazot, and GK Mega (Czech Republic). Among the prospective customers are dairy industry enterprises in Russia and its neighbouring countries, as well as enterprises which are eager to increase the efficiency of raw material utilisation and lower the amount of industrial waste.

#### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Participants of the project registered a number of patents on ion-exchange membranes. The results of intellectual activity were introduced at real economic sector enterprises in collaboration with OOO Innovative Enterprise Shchekinoazot and GK Mega (Czech Republic). Patents based on the results of development and application of electrodialysis technologies, and technologies of new generation ion-exchange membranes production are to be registered.

#### ■ STAGE OF PROGRESS

Samples of modified membranes were synthesised, prototypes of electro-dialysis machines were constructed, and electrodialysis technologies and automation systems were developed. Intellectual property rights are protected by invention patents.

Electrodialysis technologies are now being introduced at various enterprises in Russia and its neighbouring countries. The results of testing of the proposed technologies were presented at several Russian and international technological exhibitions.



#### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Pavel Kulintsov,*

lead engineer of the Department of Organic Chemistry of the Faculty of Chemistry of VSU.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

30,000,000.

#### ■ SOURCES OF FUNDING

- R&D projects, industrial tests, and equipment commissioning conducted on the contract basis
- Targeted subsidies from the funds of the Ministry of Education and Science of the Russian Federation
- Investment by industrial partners
- Grants won within the framework of the federal target programme
- Participation in programmes within the framework of the Decree of the Government of the Russian Federation №218 "State support of development of cooperation between Russian universities and organisations that realise integrated hi-tech production projects".



### ■ PROJECT PRODUCT

- Potentiometric multisensor systems used to detect counterfeited food and medicinal products, to identify amino acids, vitamins, and medical substances during their industrial production and purification, and to identify medical substances in wastewater.
- A hardware-software system and its components: multi-channel programmable potentiometers, software, and measurement cells.
- A service for the analysis of food, pharmaceutical and medical products, and medical waste.
- Development of tailored multisensor systems.

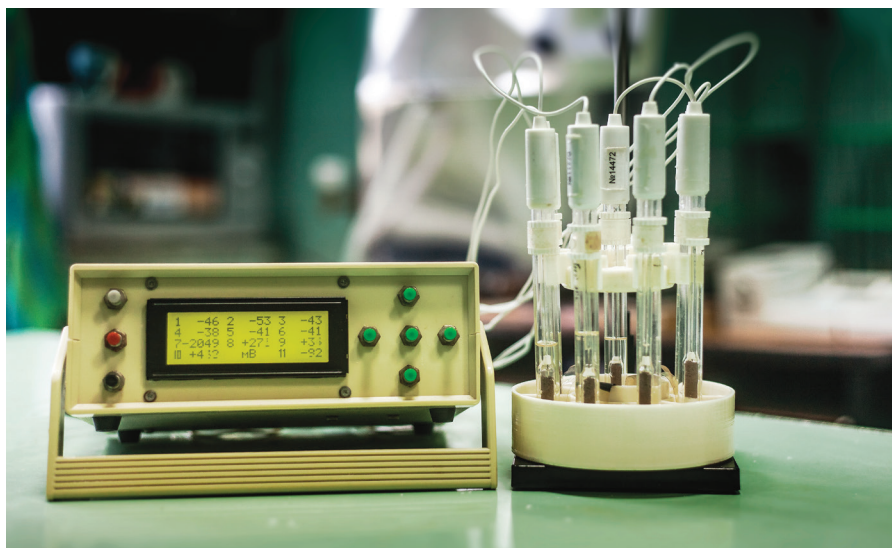
### ■ DURATION OF THE PROJECT

Since 2009.

### ■ PROJECT PAYBACK TIME

6 years.

## MULTISENSOR SYSTEMS BASED ON HYBRID MEMBRANES FOR EXPRESS ANALYSIS OF FOOD, PHARMACEUTICAL, MEDICAL PRODUCTS, AND INDUSTRIAL-MUNICIPAL WASTEWATER



A joint project by the Department Analytical Chemistry at the Faculty of Chemistry of VSU and the Laboratory of Functional Materials Ionics at Kurnakov Institute of General and Inorganic Chemistry of the Russian Academy of Sciences is aimed at developing comparatively simple and inexpensive sensor devices that can quickly perform the analysis in production lines, without sample preparation and outside of specialised laboratories. A new approach to potentiometric sensors with an internal comparison solution allows us to use graded perfluorosulfonic acid cation exchange membranes. The Donnan potential is used as an analytical signal for these membranes and the transmembrane transport is eliminated. The variability of the characteristics of the DP-sensors is achieved by altering the sorption conditions and fixing the analyte ions in the membrane by introducing dopant nanoparticles (including the surface-modified nanoparticles) and thermal treatment. Multisensor systems ensure low detection limits and high accuracy of identification of amino acids, vitamins, and medicinal substances (including the chemical analogues of drugs) in complex media, as well as the quality of the analysis of these media.

High-impedance multichannel potentiometers and special software were designed to automate the analysis. The technical level of the multisensor systems has been noted at a number of industrial forums and exhibitions. Among the expected social and economic effects of the introduction of these systems are an improved environmental situation, higher living standards by decreasing the number of counterfeited food and medicinal products, and the control of medical waste management.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

High accuracy of identification of a large number of organic analytes; ecological analysis performed without reagents; portability, automation, quick speed of the analysis, and low cost.



## ■ STAGE OF PROGRESS

A pilot batch was produced. It is now used in the studies performed by the Department Analytical Chemistry at the Faculty of Chemistry of VSU. One multisensor system was purchased by OOO Flomex for the Pivasyi restaurant (Voronezh). License agreements with OOO Voronezhselmash. Engineering and software documentation for the production of the systems. Research is carried out in order to broaden the range of analysed objects and improve the characteristics of the DP-sensors by using new hybrid membranes.

## ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

OOO Voronezhselmash, OOO SEL, and the Research and Production Company ISTOK PKS (Voronezh) approved the production of the multisensor systems. This will help to develop the domestic market of instrumental express analysis techniques. The target market are the food, pharmaceutical and chemical industries, as well as medical diagnostics agencies and regulatory bodies.

## ■ COMMERCIALISATION RISKS

Research and technical, production, and human resources risks are minimised since the research is performed on a very high level by highly qualified professionals, and all of the expendable materials are produced in Russia and are cheap. Commercial and financial risks will be reduced by investing in the promotion of the product and attracting extra funding.

## ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

Over 75,000,000 (budgetary funds);  
45,000,000 (extra-budgetary financing).

## ■ SOURCES OF FUNDING

Russian Foundation for Basic Research (grants 09-03-97505-r-centre\_a, 12-08-00743-a, 12-08-31471-moL\_a, 13-03-97502-r\_centre\_a, 13-08-12103-ofi\_m, 19-48-363008\_r\_moL\_a), Russian Science Foundation (agreement No. 15-13-10036), the Ministry of Education and Science of the Russian Federation (agreement No. 14.577.21.0005), the Foundation for Assistance to Small Innovative Enterprises in Science and Technology (U.M.N.I.K programme) (Contracts No. 8080r/12604 and 9591r/14212, 8960r/14035 and 10495r/16871, 10493r/16870 and 12128r20823, 8080r/1401 and 11710r/17209, 3547GU1/2014 and 9772GU2/2015, 14285GU/2019), grant of the President of the Russian Federation for support of young Russian scientists (SP 1749.2015.4, SP 2608.2019.4), and OOO Voronezhselmash.



## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Anna Parshina,*

DSc in Chemistry, Associate Professor at the Department Analytical Chemistry at the Faculty of Chemistry of VSU.

*Olga Bobreshova,*

DSc in Chemistry, Associate Professor at the Department Analytical Chemistry at the Faculty of Chemistry of VSU.

*Ekaterina Safronova,*

PhD in Chemical Sciences, head research fellow at the Laboratory of Functional Materials Ionics at Kurnakov Institute of General and Inorganic Chemistry of the Russian Academy of Sciences.

*Andrey Yaroslavtsev,*

DSc in Chemistry, Professor, Associate Member of the Russian Academy of Sciences, Head of the Laboratory of Functional Materials Ionics at Kurnakov Institute of General and Inorganic Chemistry of the Russian Academy of Sciences.

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

9 patents, 3 computer programmes and database certificates, and officially registered non-exclusive license agreements for the right to use intellectual property.

### ■ PROJECT PRODUCT

Production technology for peat-humic fertilizers with biopesticide properties.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

Small innovative business OOO Institute of System Biotechnologies. [www.agrobiolab.ru](http://www.agrobiolab.ru)

### ■ STAGE OF PROGRESS.

Launched in 2019.

### ■ ADVANTAGES OVER EXISTING ANALOGUES.

The fertilizers come in the form of aqueous suspension, which makes it easy to measure out the fungi spores and ensure their safety.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

6,500,000 to move to the federal level.

### ■ SOURCES OF FUNDING

- Internal financing.
- Reinvestment of profits.

We are currently searching for investors.

### ■ COMMERCIALISATION RISKS

Political risks are possible associated with the registration of the products.

## CREATION AND PRODUCTION OF COMPOUND FERTILIZERS WITH BIOINSECTICIDE, BIOFUNGICIDE, BIOACARICIDE, AND BIONEMATOCIDE PROPERTIES

Agricultural plants are usually grown without natural symbionts regardless of their effect on fertility, adaptability to stressful conditions, and susceptibility to pathogens. Instead, inorganic fertilizers (pesticides and other toxic chemicals) are used to increase the yields. These fertilizers are accumulated in the soil, can be later found in food products, and disturb the natural balance for all the members of the biocoenosis.

As a result, soil is contaminated with pathogenic microorganisms, and the natural macro- and microelements cycle is disturbed.

Similar to bacteria, soil fungi effectively decompose organic residues. At the same time, being eukaryotic they have a significantly larger genetic apparatus which helped them to occupy practically every natural environment. It is soil fungi that determine the productivity of plants by forming the mycorrhiza, and producing hormones and vitamins. They also increase soil fertility by actively decomposing organic elements and controlling the number of bacteria, insects, worms, and mites.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Know-how. Microfungi were used in the USSR for soil treatment. Today, plant science follows the interests of transnational chemical corporations. We aim to promote organic production and contribute to the health of our nation.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Agricultural companies specialising in organic products.

### ■ DURATION OF THE PROJECT

The project is now in progress. 2-3 years are required to move on to the next stage (registration in the register of the Ministry of Agriculture of the Russian Federation).

### ■ PROJECT PAYBACK PERIOD

The project started bringing profits after a year of its implementation.



## DEVELOPMENT OF NEW CORROSION INHIBITORS FOR NON-FERROUS METALS BASED ON THE FUNCTIONAL DERIVATIVES OF AMINOTRIAZOLE

The objective of the project is to develop the production of functional derivatives of aminotriazole that demonstrate anticorrosion activity on the surface of non-ferrous metals. The first samples were received and their passivating power for copper examined. There are plans of expanding the range of aminotriazole derivatives, as well as setting up the production aimed at selling corrosion inhibitors.



### ■ ADVANTAGES OVER EXISTING ANALOGUES

Low production cost, wide range of derivatives, low price of end products, high effectiveness with low concentrations, highly effective protection.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

An invention patent was registered, a patent application submitted. It is planned to register more patents.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

PAO Pigment (Tambov) OOO LKM Group (Lipetsk) and other paint material manufacturers House management companies in Voronezh and the Voronezh Region Production plants and large enterprises in Voronezh and the Voronezh Region.

### ■ COMMERCIALISATION RISKS

- Risks connected with the current political and economic situation in Russia.
- Risks associated with innovation projects.
- Production risks.

### ■ PROJECT PRODUCT

Corrosion inhibitors for non-ferrous metals.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Alexey Kruzhilin,*

lead engineer of the Department of Organic Chemistry of the Faculty of Chemistry of VSU.

### ■ STAGE OF PROGRESS

Pre-seed stage. Methods of synthesising derivatives of aminotriazole with proven passivating properties were developed.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

7,000,000.

### ■ SOURCES OF FUNDING

- Internal financing.
- Potential investors
- Federal State-Funded Educational Institution "Foundation for Assistance to Small Innovative Enterprises in Science and Technology".

### ■ DURATION OF THE PROJECT

3 years.

### ■ PROJECT PAYBACK TIME

2 years.



### ■ PROJECT PRODUCT

A wide range of high-performance emulsifiers based on plant oils and their processing waste.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The competitiveness of the products is based on their lower production cost as compared to foreign and Russian analogues, due to the fact, that the enterprise uses its own raw material (sunflower, soya-bean oil, and palm oils) and wastes of oils and fats production, as well as advanced production technologies.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

68,000,000, including 34,000,000 of subsidies, and another 34,000,000 of extra-budgetary funds.

### ■ SOURCES OF FUNDING

50 % (34,000,000) – federal budget, 50 % (34,000,000) – extra-budgetary financing.

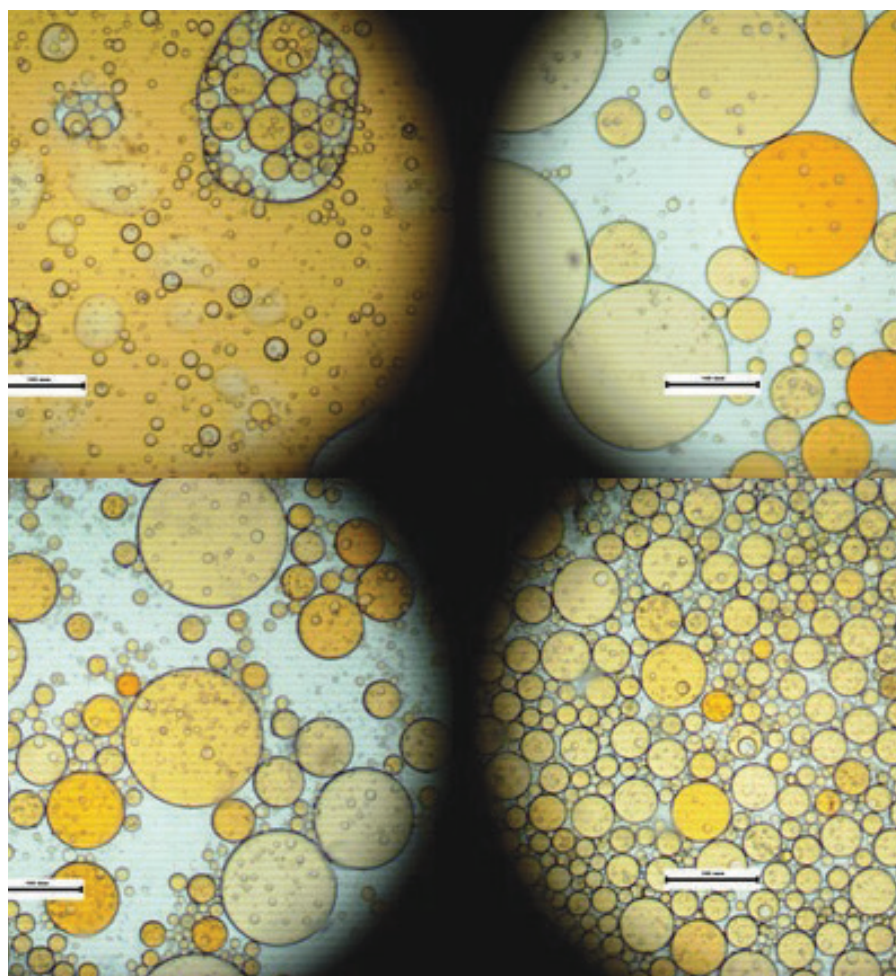
## DEVELOPMENT OF ENERGY-SAVING TECHNOLOGIES USED IN THE PROCESS OF PRODUCTION OF EMULSIFIERS AND EMULSIFYING SYSTEMS FOR THE FOOD AND NON-FOOD INDUSTRIES BASED ON RAW MATERIALS AND THEIR DERIVATIVE PRODUCTS

The aim of the project is to create new high-performance energy-saving technologies used in the process of production of emulsifiers using renewable natural resources, including biocatalysts unprecedented in Russia and providing import substitution solutions in the industry.

The proposed technology allows to:

- recycle plant raw materials and oils processing waste
- produce a wide range of individual emulsifiers and emulsifying systems with set properties by modifying the fatty acid composition of a specific component.

The project's products and the proposed technology have no analogues in Russia, and thus, the project will provide import substituting solutions in food emulsifiers industry.



## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Method of polyglycerol and fatty acids of vegetable oils esters obtaining No. 2651268 / Kh. S. Shikhaliev, M. Yu. Krysin, A. V. Zorina, N. V. Stolpovskaya, D. V. Lyapun, A. A. Kruxhilin; Moscow, 2018; (application No. 2016149545, received 16.12.2016, registered in the state register of the Russian Federation on 19.04.2018, published 19.04.2018; statement No. 12).
- Method of polyglycerol and fatty acids of vegetable oils esters obtaining No. 2652378 / Kh. S. Shikhaliev, M. Yu. Krysin, A. V. Zorina, N. V. Stolpovskaya, D. V. Lyapun, A. A. Kruxhilin; Moscow, 2018; (application No. 2017141121, received 16.12.2016, registered in the state register of the Russian Federation on 19.04.2018, published 19.04.2018; statement No. 12).
- A technology for stimulating the growth and productivity of tomato plants using compounds of pyrimidinecarboxylic acids: patent No. 2678119, Russian Federation, IPC A 61 N43/54, A 61 N37/10, A 61 N43/60, A 61 P 21/00 / T. V. Baranova, N. V. Kalaev, Kh. S. Shikhaliev, A. Yu. Potapov; author and patent holder: Voronezh State University. — No. 2017141122; submitted 27.11.2017; published 23.01.2019. — Moscow, 2019. — statement No. 3, 9 c.
- Method for stimulating growth of species of genus Rhododendron L. using compounds of a series of pyrimidine carboxylic acids: patent No. 2663068 / T. V. Baranova, N. V. Kalaev, Kh. S. Shikhaliev, A. Yu. Potapov; Moscow, 2018; (application No. 2017141123, submitted 01.08.2018, registered in the state register of the Russian Federation on 01.08.2018; published 01.08.2018; statement No. 22).

## ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Prospective consumers of the product are companies and enterprises working in the food industry, cosmetics, personal hygiene products, household chemicals and cleaners and medical industries.

OOO EFKO Food Ingredients is currently employing imported emulsifiers. The internal consumption market will thus total 137,000 tons a year.

## ■ STAGE OF PROGRESS

We designed and implemented technologies for the production of a wide range of emulsifiers based on fatty acids of oils, including monoglycerides, polyglycerol esters of different esterification degree, fatty acid alkanolamid sulfocationites and succinates, 2-alkyl-4-(2-hydroxyethyl)-imidazolines and their modification products, 5-alkyl-3-amino-1,2,4-triazoles and their modification products, and 2-R-4-alkyl-5-amino-1,3,5-triazines.

Consumer performance of the oil-based emulsifiers when used in food production was examined thanks to the investment by the industrial partner OAO EFKO. The possibility of their use in food products was demonstrated. Technologies for synthesising monoglyceride fatty acids were developed based on using plant oils and biocatalysis application.

## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

The project was initiated by OAO EFKO of the EFKO Group of companies.

## ■ COMMERCIALISATION RISKS

At the moment, the following risks are highly probable: price and currency exchange rate fluctuations, manufacturing risks (equipment failure, various defects); Force majeure.

## ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

4 years.

## ■ DURATION OF THE PROJECT

2015 г. по настоящее время.

**PROJECT PRODUCT**

Synthesis technology of mesoporous mesophase (MM) materials based on silicon dioxide.

**ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT**

Metallurgical, chemical industries, medicine and agriculture.

**DURATION OF THE PROJECT**

2019–2027.

## CREATION OF HIGH-TECH PRODUCTION OF INNOVATIVE MULTIFUNCTION SILICON-CONTAINING MATERIALS OF THE MM SERIES



An innovative technology for the synthesis of mesoporous mesophase (MM) materials based on silicon dioxide, allowing to vary their texture characteristics depending on active tasks was developed. Modification of the considered inorganic silicon-containing materials expands the possibilities of controlling analytical processes, taking into account the affinity of sorbents and their selectivity for analyte molecules. The implementation of the project will create a new strategic raw material base for a number of industries of the country and establish the production of mesoporous silicon-containing materials and composites based on it on a qualitatively new level, which will ensure high manufacturability, and, consequently, low cost of their industrial production, allowing to produce materials and products with high competitive ability due to the high quality of the material and low cost. This will allow increasing the volume of production for the chemical and pharmaceutical industries, electrical and instrument manufacture, ensuring efficient waste-free processing of natural raw materials, reducing the environmental load on the region, increasing export potential and import substitution.



### ■ ADVANTAGES OVER EXISTING ANALOGUES

The scientific novelty of the presented project is due to the potential properties of innovative mesoporous mesophase materials in the processes of isolation, separation, concentration of the biologically active substances (BAS) and the determination of BAS. It is proposed to develop methods for the analysis, isolation, and concentration of substances based on supramolecular processes according to the concepts of using highly effective nanostructured silicates and organo-functionalized composites based on them. This will allow us to separate substances with antioxidant activity with similar physicochemical properties for their potential use in the pharmaceutical and food industries.

The synthesis of a new class of materials - inorganic polymers with molecular imprints of physiologically active substances (molecular imprinted polymers, MIPs), representing a new generation of sorbents is being developed. Such highly efficient composite materials are highly selective for target components, which allows increasing the degree of extraction of analytes, reducing the costs of toxic substances (solvents) used in technological processes.

### ■ COMMERCIALISATION RISKS

- Scientific and technical.
- Industrial.
- Market.
- Financial.
- Human resources risks.



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Lilia Sinyayeva,*

PhD in Chemistry, engineer of the Centre for Collective Use of Scientific Equipment of the Department of Innovations and Enterprise of VSU.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

12,350,000.

### ■ SOURCES OF FUNDING

- Fund for Promotion of Innovations.
- Prospective investors.
- Internal financing.

### ■ PROJECT PRODUCT

According to the developed technology, the first inulin samples with a purity of  $96 \pm 2\%$  with a yield of the target product of up to 20.75% were obtained using laboratory equipment at the pharmaceutical faculty of VSU.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

We cooperate with several enterprises. We have a letter and an agreement regarding scientific and technical cooperation with the Moscow company OOO Kvadrat-C, producing and developing new compositions of medicinal products and dietary supplements based on inulin, interested in our project. In addition, numerous manufacturers of dairy and confectionery products will become potential buyers of the proposed product.

## INNOVATIVE TECHNOLOGY FOR OBTAINING INULIN FROM PLANT SOURCES



Inulin is a natural polyfructosan, partially digested to fructose in the gastrointestinal tract. The undegraded part of inulin is an active sorbent, removing many toxins, such as heavy metals, radionuclides, excess of low-density lipoproteins from the body.

Inulin is a prebiotic, promoting the development of the normal functioning of the gastrointestinal tract. A lot of medicinal products and dietary supplements, including domestic ones are produced based on inulin. Inulin is high-demand sugar substitute for patients with diabetes mellitus. It also acts as fat substitute and is used for the production of low-calorie confectionery and dairy products.

Currently, only inulin produced by foreign manufacturers, characterized by a fairly high cost, is present on the Russian market. The patented technologies for the production of inulin are characterized by low product yield and a considerable duration, the extraction of raw materials takes up to 3-5 days.

The aim of the project is the production of inulin substances from the roots of dandelion, the roots and leaves of burdock, the roots of sunflower and the roots of elecampane for use in medicine, pharmacy, cosmetic and food industries.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Availability of a plant source of inulin, which has significant raw material reserves in Russia.
- Domestic production of inulin substance, which is of particular importance in the light of the concept of strategic development of the pharmaceutical industry of the Russian Federation, in accordance with which it is necessary to establish domestic production of medicinal products, bringing their share to 50% of the market.
- Reduction of the technological process from 3-5 days to 6 hours.
- An increase in the yield of the finished product by 10-20% in comparison with previously known methods for the isolation of WSP.
- Reducing the cost of the finished product.

## ■ STAGE OF PROGRESS

- 2020 - the completion of research, in particular on the development of technological regulations for the production of inulin.
- 2021–2027 - industrial mass production of inulin. It is planned to launch the production of inulin substances and sell it to partners, which may include manufacturers of medicinal products and prebiotic dietary supplements, manufacturers of dairy and confectionery products, manufacturers of sugar substitutes.

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Currently, the author of the project has developed and patented technologies for the express production of water-soluble polysaccharides from the following types of plant materials:

- from the leaves of waybread (Pat. 2530501 Method of production of water-soluble polysaccharides from leaves of waybread, published 10.10.2014, statement No. 28);
- from the roots of great burdock (Pat. 2604934 Method of production of water-soluble polysaccharides from roots of great burdock, published 20.12.2016, statement No. 35.);
- from the roots of milk gowan (Pat. 2635996 Method of water-soluble polysaccharides extraction from milk gowan roots, published 17.11.2017, statement No. 32);
- from the leaves of great burdock (Pat. 2656398 Method of production of water-soluble polysaccharides from leaves of great burdock, published 05.06.2018, statement No. 18).

In addition, in May 2019, research on the purification of the resulting amount of water-soluble polysaccharides for the production of the inulin was completed, and two more applications for the invention were submitted:

- "Method for obtaining inulin from plant materials" (application No. 2019115734 dated 22.05.2019);
- "Method for obtaining purified inulin from plant materials" (application No. 2019115731 dated 22.05.2019).

## ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

Purchase of equipment (about 800 thousand roubles). The wholesale cost of 1 kg of raw materials is about 300 roubles. Purchase of necessary solvents and reagents is about 200 roubles per 1 kg of products. Thus, the cost of 1 kg of inulin is from 1700 roubles, i.e. 1.7 roubles per 1 g. The price of produced inulin depends on the degree of purification and can be about 3.2 thousand roubles per 1 kg.

## ■ SOURCES OF FUNDING

It is planned to submit an application to the Start-1 programme for financial support for the completion of technological research and the organization of small innovative enterprise for the production of inulin.

If the application is successful, by 2020 it is planned to obtain funds from the Fund for the Promotion of Innovations in the amount of 2 million roubles for R&D on the development of process procedures for the production of inulin and its quality indicators.

If the project plan will be successfully implemented, from 2022 the small innovative enterprise will not need to raise external funds.

## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Dyakova Nina  
Alekseevna,*

PhD in Biology, associate professor at the Department of Pharmaceutical Chemistry and Pharmaceutical Technology of VSU.

## ■ DURATION OF THE PROJECT

It is planned to complete all research and development in 2020 and to perform all the necessary tests and start production by no later than 2021.

## ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

1 year.

## ■ COMMERCIALISATION RISKS

- Commercial risks. All calculations used for the business model are based on the analysis of the economic performance of the production efficiency and the real situation on the market.
- Sales risk. The potential capacity of the inulin market exceeds the current supply level by several tens of times.



### ■ PROJECT PRODUCT

Technology for producing capsules that will contain microcapsules with sustained action drugs.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The production of these medicinal products will solve a number of existing problems with the development of medicinal products, namely:

- The ability to control the release rate of substances from the capsules.
- Reducing the effects of adverse factors on substances placed in microcapsules.
- Reducing the dosage frequency of medicinal products. It is quite relevant for prolonged use of medicinal products.

## DEVELOPMENT OF SUSTAINED RELEASE ENCAPSULATED DOSAGE FORMS FOR THE TREATMENT OF CENTRAL NERVOUS SYSTEM DISEASES

One of the leading trends in modern pharmacology is the study of targeted delivery of medicine. A prerequisite for its appearance was the fact that when we administer medication by traditional methods, the medication is distributed evenly in our body. Before it can actually have its therapeutic effect on the target organ, the medicine also enters to other organs, where its effect may be rather undesirable. In addition, the medicine reaches its biological target in much smaller concentrations than required, which makes it necessary to increase the dosage by two or three times.

The implementation of targeted concentration of the medicinal product exclusively or at least mainly in the area covered by the pathological process, can drastically reduce undesirable reactions of the body to medication, reduce the therapeutic dose of the medicinal product and the frequency of its administration.

Targeted delivery of medication is not unlike precision bombing, as it helps to avoid undesirable reactions, as well as to lower the dosage and the frequency of administration.

Today, one of the most popular and desirable dosage form is microcapsules. This kind of medicinal formulation helps to lower the effect of moisture on the stability of the active substance.

Placing microcapsules inside capsules can result in a significant prolongation of the pharmacological effect.

This kind of medicinal formulation helps to protect the medicinal product contained in them from the destructive effects of the stomach environment and ensures that the drug enters the lower gastrointestinal tract, where it can be most effectively absorbed by mucosal cells. The importance of these properties will also be valid for microcapsules "loaded" with medicinal product. The main focus of the project is the development of a technology for producing capsules that will contain microcapsules with sustained action medicine.

The inclusion of microcapsules with a different shell in the composition provides a controlled release of active ingredients.

Well-known medicinal substances, widely used for the treatment of diseases of the central nervous system can be included in the capsule composition as active ingredients.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Pat. 2642275 RF, IPC51 G01J 3/00. Method for the quantitative determination of phenibut in microcapsules by capillary electrophoresis [Electronic resource] / Yu. A. Polkovnikova, A. I. Slivkin (Russian Federation) No. 2016136544; application 12.09.16; published 24.01.2018.- 10 p.
- Pat. 2662173 RF, IPC51 A61K 9/00 A61K 9/50 A61K 31/197 Method for producing particles of microcapsulated phenibut in alginate sodium [Electronic resource] / Yu. A. Polkovnikova (Russian Federation) No. 2017106438; application 27.02.17; published 07.24.2018.- 7 p.

■ **ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT**

Pharmaceutical companies that produce psychotropic medication.

■ **COMMERCIALISATION RISKS**

- Scientific and technical risk.
- Production risk.
- Commercial (market) risk.
- Financial risk.
- Human resources risks.



■ **INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)**

*Julia Polkovnikova,*

PhD in Pharmaceutics, associate professor at the Department of Pharmaceutical Chemistry and Pharmaceutical Technology of the Faculty of Pharmaceutics of VSU.

■ **TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES**

3,000,000.

■ **SOURCES OF FUNDING**

Grant of the President of the Russian Federation for the state support of young Russian scientists – candidates of sciences (MK-3317.2015.7).

Scholarship of the President of the Russian Federation for the Support of Young Russian Scientists(SP-95.2018.4).

■ **DURATION OF THE PROJECT**

1 year.

■ **PROJECT PAYBACK PERIOD**

1 year.

### ■ PROJECT PRODUCT

A modern safe alternative to antibiotics and chemotherapy for the treatment of wounds and wound infections, including those resistant to antibiotics.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- High clinical efficacy.
- Prolonged action.
- Low toxicity.
- Frequency of allergic reactions.

### ■ PROJECT PAYBACK PERIOD

About 8 years.

### ■ DURATION OF THE PROJECT

6–7 years.

### ■ COMMERCIALISATION RISKS

Commercialization risks of research projects are twice as high as the average risk and are 18-20%. The major risks can result from insufficient financing of the project at the R&D stage and potential industrial espionage.

## DEVELOPMENT OF AN INNOVATIVE TECHNOLOGY FOR THE GENERATION OF WOUND HEALING MULTI-ENZYMATIC MEDICATION “ZAZHIVIN”



A technology for heterogeneous enzyme preparations for medical purposes was developed. The preparations combine low toxicity and low allergic response with higher clinical effectiveness compared to existing similar products. A pilot batch of heterogeneous enzyme preparations was produced. They will serve as an active substance of the medicinal products used locally to treat wounds, burns, chancres, post-operative suture, and scars.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The Voronezh region has pharmaceutical manufacturing companies (ZAO Areal, OOO Experimental Pharmaceutical Plant №1, OOO Experimental Pharmaceutical Plant №2, OOO NPP Avitsenna, etc.) that can be involved in the production of the end product, developed as a result of the project.

A wide range of institutions can be interested in the results of the project: sanitation-and-epidemiological, medical, and veterinary institutions that deal with pathogenic and opportunistic pathogenic microflora.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Invention patent No. 2677232 “Method for obtaining heterogeneous preparation of various dispersities based on bromelain and chitosan” / M. G. Kholyavka, V. G. Artyukhov, V. A. Koroleva Application No. 2017123458. Priority of the invention dated 03.07.2017. Registration date 16.01.2019. Period of validity 03.07.2037.
- Invention patent No. 2677343 Method for obtaining heterogeneous preparation based on bromelain with the wound-healing properties”/ M. G. Kholyavka, V. G. Artyukhov, S. M. Sazykina Application No. 2017123459. Priority of the invention dated 03.07.2017. Registration date 16.01.2019. Period of validity 03.07.2037.



- Invention patent No. 2677873 “Method of obtaining a heterogeneous drug based on papain” / M. G. Kholyavka, V. G. Artyukhov, V. A. Koroleva Application No. 2017123457. Priority of the invention dated 03.07.2017. Registration date 22.01.2019. Period of validity 03.07.2037.
- Invention patent No. 2677858 “Method for obtaining heterogeneous enzyme preparation based on ficin, with wound-healing and regenerative properties” / M. G. Kholyavka, V. G. Artyukhov, V. A. Koroleva Application No. 2017123462. Priority of the invention dated 03.07.2017. Registration date 22.01.2019. Period of validity 03.07.2037.
- Invention patent No. 2678435 “Method of obtaining a heterogeneous drug based on collagenase and chitosan” / M. G. Kholyavka, V. G. Artyukhov, S. S. Olshannikova Application No. 2017123460 Priority of the invention dated 03.07.2017. Registration date 29.01.2019. Period of validity 03.07.2037.
- Certificate of state registration of a computer program No. 2019616471 “Program for implementing the algorithm for searching for clusters of charged and hydrophobic amino acid residues on the surface of protein molecules” / F. A. Sakibaev, M. G. Kholyavka, V. G. Artyukhov Moscow, 2019. - 13.7 Kb. - Application No. 2019611498. Application date 18.02.2019, published 23.05.2019.
- Certificate of state registration of a computer program No. 2019662440 “Program for selecting models of the spatial structure of protein dimers with specified parameters” / F. A. Sakibaev, M. G. Kholyavka, V. G. Artyukhov Moscow, 2019. - 4.2 Kb. - Application No.2019661165. Application date 11.09.2019, published 24.09.2019.
- Invention patent No. 2691611 “Method of producing a bromelain in gel based on food chitosan and chitosan succinate” / M. G. Kholyavka, S. S. Olshannikova, V. G. Artyukhov Application No. 2018142931. Priority of the invention dated 04.12.2018. Registration date 14.06.2019. Period of validity 04.12.2038.
- Invention patent No. 2711790 “Method of producing polybromelain preparation using glutaric aldehyde” / M. G. Kholyavka, S. S. Olshannikova, V. G. Artyukhov Application No. 2018146923. Priority of the invention dated 26.12.2018. Registration date 22.01.2020. Period of validity 12.26.2038.
- Invention patent No. 2711790 “Method for producing a heterogeneous bromelaine preparation which is covalently bound to a chitosan matrix” / M. G. Kholyavka, S. S. Olshannikova, V. G. Artyukhov Application No. 2018146925. Priority of the invention dated 26.12.2018. Registration date 22.01.2020. Period of validity 12.26.2038.
- Invention patent No. 2712528 “Method for producing collagenase preparation in gel based on food chitosan and chitosan succinate / M. G. Kholyavka, S. S. Olshannikova, V. G. Artyukhov Application No. 2018142755. Priority of the invention dated 03.12.2018. Registration date 29.01.2020. Period of validity 03.12.2038.

#### ■ STAGE OF PROGRESS

The technological solutions of the project are based on research results. Trypsin, bromelin, ficine, papaine, and collagenase were immobilized on chitosan of various polymerization levels and VION fibers. A method of trypsin immobilization on chitosan that enables saving up to 94% of the enzyme activity was suggested. The optimum conditions for this preparation functioning were determined. Their physical, chemical, and kinetic properties were investigated.

#### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Marina Kholyavka,*

DSc in Biology, associate professor at the Department of Biophysics and Biotechnology of the Faculty of Biomedical Sciences of VSU.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

About 6,000,000.

#### ■ SOURCES OF FUNDING

It is planned to obtain funding from Bortnik Fund (U.M.N.I.K. and START programmes) and the Federal Target Program. Among other expected financing are subsidies provided in the framework of the governmental support of small and medium businesses by subjects of the Russian Federation in accordance with article 78 of the Budgetary Code of the Russian Federation and the Decree of the Government of the Russian Federation of 27.02.2009 № 178.

### ■ PROJECT PRODUCT

Innovative technology of preliminary thermomechanical treatment aimed at hardening cutting and measuring tools.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

10,000,000.

### ■ SOURCES OF FUNDING

- The Foundation for Assistance to Small Innovative Enterprises in Science and Technology.
- Industrial partner financing.
- Inner financing.

## INNOVATIVE TECHNOLOGY FOR PRELIMINARY THERMOMECHANICAL TREATMENT AIMED AT HARDENING CUTTING AND MEASURING TOOLS



Innovative technology of preliminary plastic form-based thermomechanical treatment that allows increasing cutting and measuring tools resistance more than two times.

The project develops mass-production technologies for preliminary thermomechanical treatment of instrument steel work pieces aimed at hardening cutting and measuring tools, i.e. increasing their depreciation period. These technologies allow decreasing tooling backup costs of machine workshops at machine engineering companies and decreasing companies' losses caused by the necessity to replace/repair tools. Direct analogies, i.e. organisations that introduce tool hardening technologies based on innovative preliminary thermomechanical treatment techniques, were not found. Preliminary marketing analysis revealed several companies that offer tool hardening by means of surface hardening by coating.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Low production cost.
- High fabricability (only one simple operation is added to the existing tool production technologies used at enterprises, i.e. work piece displacement upsetting when cold or hot).
- Tool lots do not need to be transported to be processed, and as a result to be stored, packaged, etc., as the enterprise's equipment can be used for the innovative preliminary thermomechanical treatment (if pressure equipment is available).
- Surface hardening by means of coating can complement the innovative preliminary thermomechanical treatment (as the tool steel microstructure is changed).

## ■ STAGE OF PROGRESS

A small innovation business OOO I-Expert Group was founded together with VSU to commercialize the project's results. The project is at the R&D stage.

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

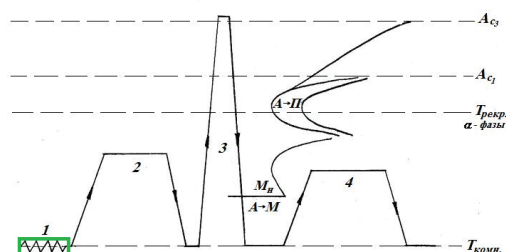
After the completion of the R&D works (2017) the obtained results of intellectual activity will be protected by an invention patent and a utility model patent issued by the Federal Institute of Industrial Property (Rospatent).

## ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

- Professional consumers.
- Large machine engineering plants with cutting and measuring tool workshops.
- Small and medium-sized businesses producing specialised tools for machine engineering companies.
- Toolmakers with a large-scale production of standard cutting tools.

## ■ COMMERCIALISATION RISKS

Commercialisation risks connected with low innovative activity of enterprises' management.



Технологическая схема ПТМО:  
 1 – **ИННОВАЦИОННАЯ ПТМО**; 2 – дорекристаллизационный нагрев (отдых);  
 3 – закалка с быстрым нагревом; 4 – окончательный отпуск.  $T_{комн.}$  – комнатная температура;  $T_{рекp.}$  – температура рекристаллизации  $\alpha$ -фазы;  $M_s$  – температура начала мартенситного превращения;  $A_{C1}$  – нижняя критическая точка при нагреве;  $A_{C2}$  – верхняя критическая точка при нагреве доэвтектидной стали;  $A \rightarrow P$  – область аустенитно – перлитного превращения;  $A \rightarrow M$  – область аустенитно – мартенситного превращения.

## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

Alexander Khvan,

head of the VSU innovative business incubator, DSc in Technical Sciences, associate professor.

## ■ DURATION OF THE PROJECT

5 years.

## ■ PROJECT PAYBACK TIME

3 years.





### PROJECT PRODUCT

Advanced device for the transportation of liquids through pipelines.

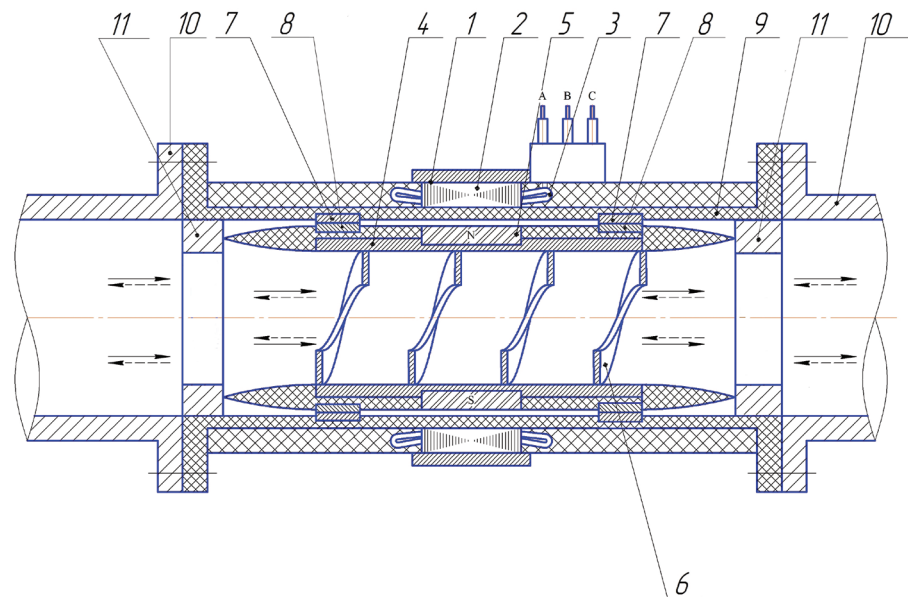
### TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

20,000,000.

### SOURCES OF FUNDING

- The Foundation for Assistance to Small Innovative Enterprises in Science and Technology.
- Industrial partner financing.
- Internal financing.

## ADVANCED DEVICE FOR THE TRANSPORTATION OF LIQUIDS THROUGH PIPELINES



An advanced device for the transportation of liquids through pipelines was developed. It is a new hydraulic electric pump with increased performance due to an increased efficiency coefficient (approximately 20%) and improved ergonomics. It is also more reliable and has a longer life time owing to its simplified construction. All the above mentioned characteristics provide for a considerably lower cost of the product. The device is designed to be used for the transport of oil and oil products to create turbulent flows in the pipeline and as a result 3-4 times faster emptying of a railway tanker car compared to the existing technologies.

### ADVANTAGES OVER EXISTING ANALOGUES

The developed innovative device for transportation of liquids through pipelines used for emptying oil tanker cars at oil depots has the following technological and operational advantages over the most advanced analogues with comparable performance and pipeline diameter:

- the cost of the device is 4-7 times lower than of the comparable analogues which allows potential consumers, oil depots, to decrease their investment in the modernisation of their drainage system and to save on tanker car demurrage charges;
- power consumption is 3-5 times lower than in case of analogues which allows oil depots to save on energy;
- lower weight and size of the device make it more mobile, interchangeable, and substitutable when used for emptying oil tanker cars, and also allows decreasing the mounting costs of a new system in case of oil depot modernisation.

■ **STAGE OF PROGRESS**

Pre-seed stage. R&D is conducted. A laboratory prototype was produced.

■ **PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT**

An application for an invention patent was submitted to the Federal Institute of Industrial Property (Rospatent).

■ **COMMERCIALISATION RISKS**

Commercial (market) risks – there is a possible failure to find the expected demand for the device, i.e. consumers will not buy a sufficient number of new devices. These risks can be offset by the recruitment of qualified sales personnel and by investment into advertising and promotion of the product.

■ **ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT**

Potential consumers of new devices for the faster emptying of oil tanks are oil depots and enterprises supplying oil products.

■ **INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)**

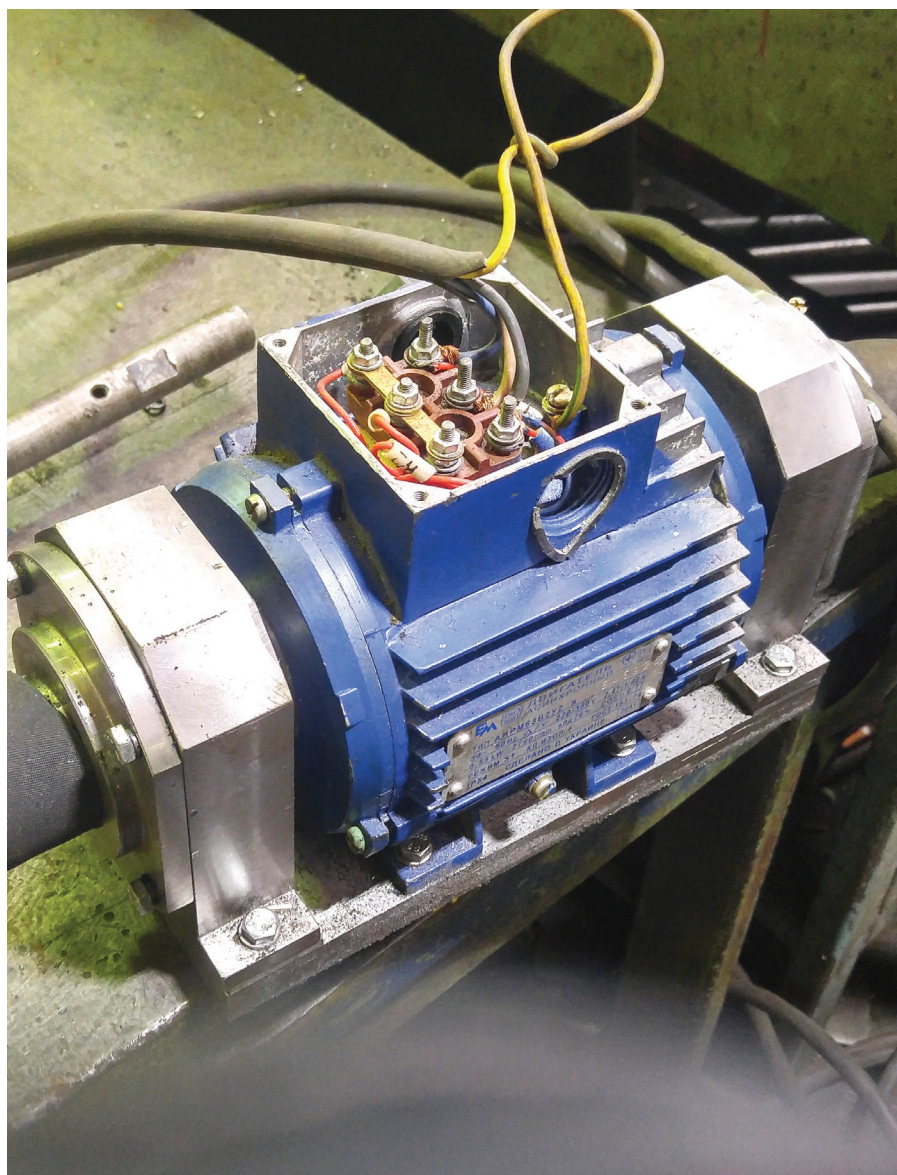
*Alexander Khvan,*  
head of the VSU innovative business incubator, DSc in Technical Sciences, associate professor.

■ **DURATION OF THE PROJECT**

5 years.

■ **PROJECT PAYBACK TIME**

2 years.



### ■ PROJECT PRODUCT

A pulse discharge pile driver device for small section reinforced concrete piles KSU - 50.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Dmitry Kostin,*

DSc in Physics and Mathematics, associate professor at the Department of Mathematical Modelling of VSU.

### ■ STAGE OF PROGRESS

Currently I. V. Nasonov developed, manufactured and successfully tested the KSVU-0.5.

### ■ DURATION OF THE PROJECT

2018–2026.

### ■ PROJECT PAYBACK TIME

2 years.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

8,550,000.

### ■ SOURCES OF FUNDING

- Foundation for Assistance to Small Innovative Enterprises in Science and Technology.
- Internal financing.

## PULSE DISCHARGE PILE DRIVER FOR SMALL SECTION REINFORCED CONCRETE PILES - HIGH EFFICIENCY, LOW ENERGY CONSUMING HYDRAULIC PRESS-IN STATIC PILE DRIVER

The project relates to the developing and manufacturing construction equipment, improving the technological resources and the effectiveness of their application for the shockless and silent piling of small section reinforced concrete piles and other pile elements into the soil. It can be used in civil, military-industrial, industrial, energy and road construction in the construction of low-rise buildings and structures.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The device is superior in its technical and economic indicators to modern foreign functional analogues (including vibration dampers and vibration hammers) of the best manufacturers in the world - Germany, Holland, the USA, France, Japan, etc. The uniqueness of the KSU-50 device is not only the novelty of the technical solution, but also its functionality, which can form pressing/pulling forces from 50 kg to 30 tons. It is equipped with hydraulic drives, which in a steady regime allows creating working efforts in the range of the indicated values.

Equipment developed on the basis of this project make a substantial contribution to import substitution, since the analogues on the market are mostly foreign-made.

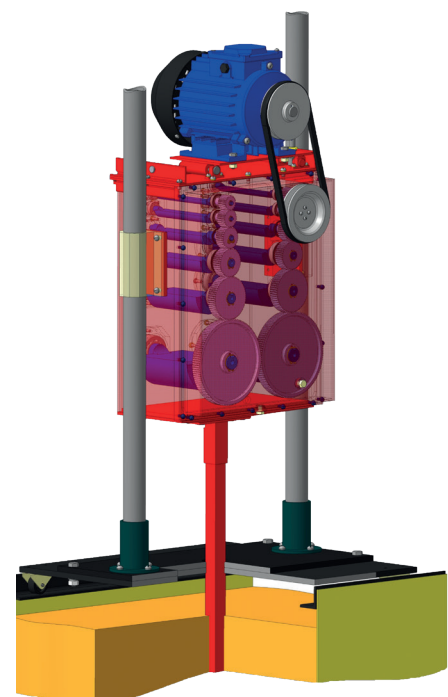
For the first time, the project implements a theoretically perfect design, allowing increasing the efficiency coefficient by 20 percent.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Construction organizations engaged in the construction of piled foundations in low-rise construction, in the civil, military, industrial, energy, and road sectors.

### ■ COMMERCIALISATION RISKS

- Scientific and technical.
- Industrial.
- Market.
- Financial.
- Human resources risks.





## FUEL PROCESSING DEVICE KNYAZ-1



Fuel processing device was developed for:

- The purification of fuel from decaying products and metal-based additives which clog fuel injection equipment in vehicles based on Euro 3 – Euro 6 standards.
- The device also generates a hydrogen additive to improve fuel emissions, power output, and economy.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- High environmental performance.
- The absence of interference with the engine.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Transport enterprises and other companies using power units with combustion engines.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- Patent No. RF172392.
- The details of the device construction will be protected as commercial secrets (know-how) without any information available about its functioning.
- The project was selected for the final of the OPEN INNOVATIONS START-UP TOUR in Kursk.

### ■ COMMERCIALISATION RISKS

- The product may cease to be unique.
- Risk of device failure.
- Unexpected suspension of production.

### ■ STAGE OF PROGRESS

A prototype of the device was produced.

### ■ PROJECT PRODUCT

A device that generates a hydrogen additive without water, without maintenance, without interfering with the work of the engine, within the fuel itself without the use of additives, etc.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*German Komarov,*

postgraduate student at the Faculty of Geology of VSU.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

11,000,000.

### ■ SOURCES OF FUNDING

- Start programme and VTB 24 lease payments.

### ■ DURATION OF THE PROJECT

5 years.

### ■ PROJECT PAYBACK TIME

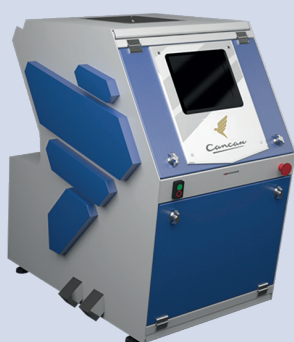
3 years.

### ■ PROJECT PRODUCT

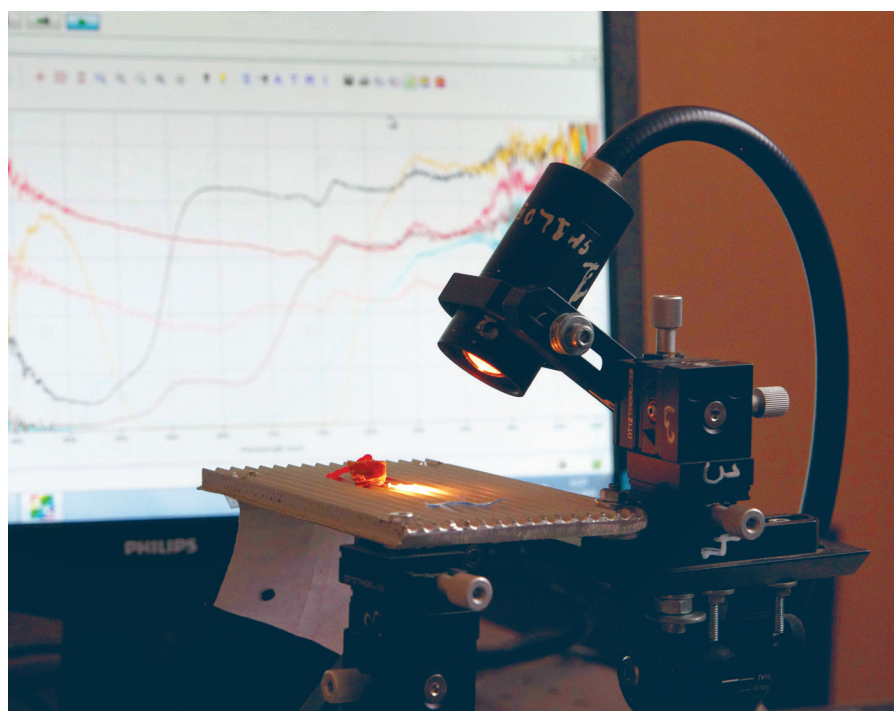
The Sapsan Micro is the flagship optical sorter for desktop applications, a fundamentally new technology, surpassing foreign analogues by technical, functional, and operational characteristics.

### ■ STAGE OF PROGRESS

- Design documentation for the Sapsan micro colour sorting machine and i6 was developed.
- Prototypes of machines were produced.
- Trail models were produced.
- Prototypes were tested.
- OOO Smart Grade started a serial production of Sapsan micro colour sorting machines.
- Since the beginning of 2018, 13 colour sorting machines have been sold.



## SERIAL PRODUCTION OF THE SAPSAN MICRO ADVANCED COLOUR SORTING MACHINE FOR SMALL AND MEDIUM SIZE AGRICULTURE AND FOOD INDUSTRY BUISNESSES



The main problem, which the project aims to solve, is the production of high-quality raw materials and food products by removing defected objects and defects by computer vision system with subsequent processing of information using modern machine learning methods. The production of such optical sorters will solve a number of problems of the food industry and agriculture.

This is an innovative approach as it develops original optical schemes and special multispectral cameras. Modern mathematical machine learning algorithms are used for digital image processing.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

Small and medium agricultural and food industry enterprises, genetic selection centres, and grain elevator complexes.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

- RF patent No. 2489215 C1, Laser sorter, A. A. Churikov et al., separation and analysis of grain of various crops, 23.11.2011.
- RF patent No. 2521215 C1, Fiber-optic laser-based sorting machine, E. M. Babishov et al., separation and analysis of grain of various crops, 12.24.2012.

### ■ COMMERCIALISATION RISKS

- Industrial.
- Human resources risks.
- Risk caused by natural and economic factors (financial, market).
- Uncertainty of future events.
- Unpredictability of partner behaviour.
- Lack of information.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- High resolution of cameras (0.1 mm).
- The effective resolution of the sensor is 0.03 mm, allowing successful operations with small-seed crops and ability to distinguish between the smallest defects/weeds.
- Mobility. Its small size and light weight provide the ability to place the colour sorting machine on the operator's desktop.
- Universality.
- Low price.
- Working with materials based on their structure provides the ability to recognize seeds by appearance.
- Low air consumption.
- Ability to work as an analyser.
- Operation in the UV-range.
- Energy efficiency. Low energy consumption contributes to lower energy costs (0.3–0.5 kW).



### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

OOO Smart Grade,  
*Elena Popova,*

engineer at the Fundamental Department of Additive Technology of VSU.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

10,000,000.

### ■ SOURCES OF FUNDING

Investments by OOO Smart Grade.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

2 years.

### ■ DURATION OF THE PROJECT

1 years.



#### ■ PROJECT PRODUCT

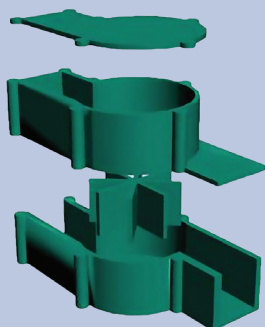
A digital spiograph that can register the maximum expiratory flow rate, breathing rate, and lung capacity. PC software and a mobile Android application with gamified breathing exercises, and a programme for analysing the dynamics of lungs functioning for each user. The product we propose is an information system consisting of the device and software.

#### ■ DURATION OF THE PROJECT

3 years.

#### ■ PROJECT PAYBACK TIME

6 years.



## FULL-SCALE PRODUCTION OF THE REHABILITATION SYSTEM BREATHE&PLAY FOR CHILDREN ENDURING PULMONARY PATHOLOGY



The system is a hardware-software system that registers breathing information and employs biofeedback (BFB) in the form of a game. The system will help children recover from lung disease and restore their lost functions. Doing breathing exercises as part of a game keeps children involved in the rehabilitation process. It is also possible to save the results of each exercise session in the database, and thus better control the process and assess the dynamics of the rehabilitation process.

At the heart of the system is a device that we developed – a digital spiograph that can register the maximum expiratory flow rate, breathing rate, and lung capacity. The system includes the PC software and a mobile Android application with gamified breathing exercises, as well as a programme for analysing the dynamics of lung functioning for each user.

#### ■ STAGE OF PROGRESS

A functioning prototype of the device and the software for gamified breathing exercises were created.

#### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Size (fits into one's palm, weighs no more than 200 g).
- Connection to a tablet or a smartphone via Bluetooth.
- Gamified exercises and rehabilitation.
- Analysis of data used in medical diagnostics methods (breathing rate, forced expiratory volume, etc.).
- Low production cost (about 2000 roubles).

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

The software is protected by the following certificates of state registration of computer programs:

- No. 2015661028 dated October 15, 2015;
- No. 2016610682 dated January 18, 2016;
- A patent for the rehabilitation methodology is about to be published;
- Invention patent No. 2688796 was received.

## ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

- Hospitals.
- Rehabilitation centres.
- Sport sections.
- Kindergartens.
- Schools.



## ■ COMMERCIALISATION RISKS

- Lack of demand. This kind of risk can be eliminated by establishing close contact with prospective customers starting from the earliest stages of the product development.
- Funding risks. Can be eliminated by attracting investors, using bank loans, and internal financing.
- Problems with certification. Certification is required only for a limited number of the system's functions concerning medical diagnostics, while the rest of its functions do not require any certification.
- Increase in competitiveness level on the market. Low production cost (about 1000 roubles) and a large number of functions allow the system to compete with already existing analogues. Continuing upgrades to the device itself and the rehabilitation methodology used will provide for a stable position on the market.

## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Alexey Maksimov,*

lecturer at the Faculty of Computer Science of VSU.

## ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

2,600,000 for the design and 4,000,000 in order to introduce the project on the market.

## ■ SOURCES OF FUNDING

- Venture investments.
- The Fund for Promotion of Small Enterprises in Scientific and Technical Field.
- Bank loans.
- Internal financing.
- The total funding currently amounts to 2,000,000 roubles.



### ■ PROJECT PRODUCT

Tactile feedback system in myoelectric prostheses and the methods of its production. Temperature feedback system in myoelectric prostheses and the methods of its production.

### ■ STAGE OF PROGRESS

A laboratory machine employing the tactile feedback system was produced.

### ■ DURATION OF THE PROJECT

2017–2020.

### ■ PROJECT PAYBACK TIME

4th year from the start of the production.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

The application is being prepared for a patent based on the “Feedback method for a myoelectric prosthesis”.

## INFORMATION SYSTEM WITH TACTILE AND TEMPERATURE FEEDBACK IN MYOELECTRIC PROSTHESES



Our system expands the functions of a myoelectric prosthesis that can be either autonomous or partly integrated into the artificial limb. The system will include tactile and temperature sensors, a single-board computer, a USB module, a tactile stimulator, and a tutorial on how to use the system.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

The problem of artificial biological feedback in the field of prostheses is becoming more and more popular. In the USA, research into feedback in myoelectric prostheses is financed by the Defence Advanced Research Projects Agency (DARPA).

Among the organisations that conduct their research in this field are the following:

- Laboratory for Soft BioElectronic Interfaces of the Swiss Federal Institute of Technology Lausanne (Switzerland);
- Perceptual Robotics Laboratory of Scuola Normale Superiore di Pisa (Italy);
- Tel Aviv University (Israel).

There are also three large companies that are leaders on the market of myoelectric prostheses without artificial biological feedback (these companies sometimes use artificial biological feedback as an experiment or in exclusive models):



- RSLSteeper;
- I-LIMB;
- Otto Bock..

All the existing analogues have the same disadvantage - high price (starting with \$ 20 000) and a lack of feedback.

There have been recently a number of projects in Russia that offer lower prices, but still have no feedback system.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The prospective customers are state and private healthcare services and hospitals such as military rehabilitation centres, myoelectric prostheses manufacturers, and the disabled and their families.

### ■ COMMERCIALISATION RISKS

- Engineering (Presence of similar systems on the market; lack of equipment necessary to conduct a thorough research and develop the software; lack of volunteers and hence, no opportunity to test the system and create a unified testing database).
- Intellectual (lack of facilities required for the research, such as laboratories, software, and volunteers); absence of one of the project's participants due to reasons (illness, business trip, or some other reason).
- Investment (lack of financing).
- Marketing (lack of the demand among the prospective consumers; inability of the prospective consumers to buy the product; lack of awareness of prospective customers about the product).

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

Laboratory of Medical Cybernetics at the Faculty of Computer Sciences of VSU.

Supervisor: Ya. Turovsky, lecturer.

Implemented by K. Fisenko, student.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

At least 5,000,000 roubles to set up a small-scale production line.

### ■ SOURCES OF FUNDING

Grant received within the framework of the programme "Participant of the Youth Scientific and Innovation Competition U.M.N.I.K." Additional financing is required in order to produce a prototype. Further financing will be required to launch small-scale production.



■ PROJECT PRODUCT

SmartWall Software and SmartWall-based applications and services that can be used in various spheres.

■ COMMERCIALISATION RISKS

- Innovation risks.
- Financial risks.
- Market risks.
- Business risks.

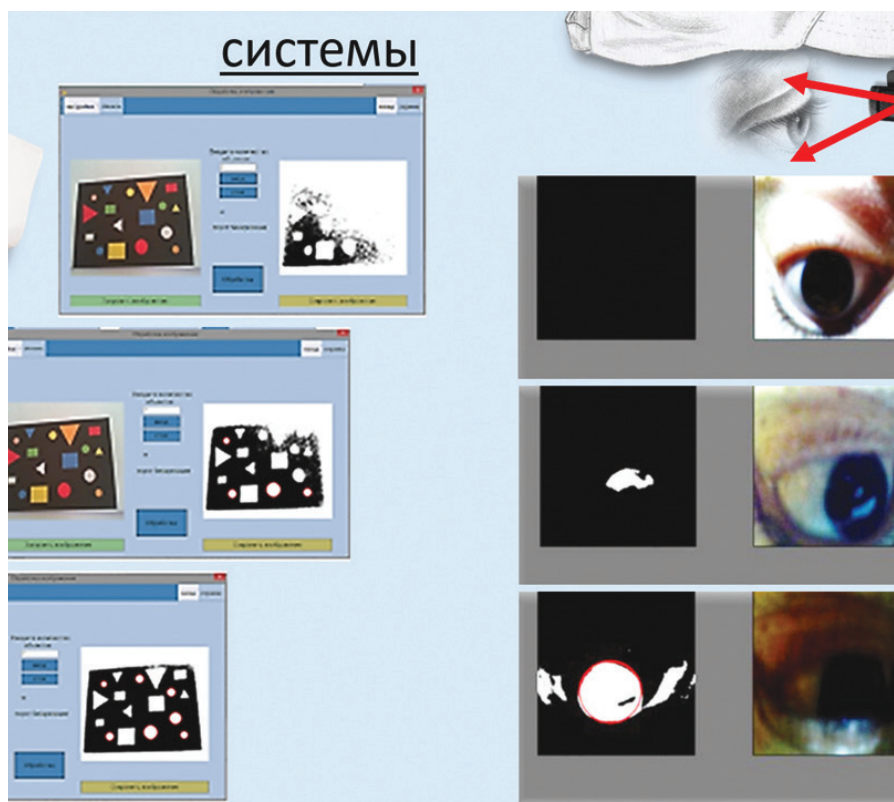
■ DURATION OF THE PROJECT

3 years.

■ PROJECT PAYBACK TIME

4th year of active sales.

## A NOVEL SMARTWALL SOFTWARE SYSTEM FOR CREATING NON-ELECTRONIC INTERACTIVE SURFACES AND GADGETS



The aim of the project is to develop SmartWall software based on a new method for the segmentation of noisy images with dynamic threshold values for image binarisation. The software makes it possible to control a computer using non-electronic surfaces such as walls, paper, or a table surface. The software uses computer vision techniques to transform any surface into an interactive element without sensing technologies. The SmartWall software was developed in Visual Studio 2013 using the C# programming language. NET Framework 4.5 is required to run the program. SmartWall-based applications run on the Microsoft Windows OS and require a webcam. SmartWall can create two types of interactive surfaces - stationary and portable. The software can be applied to surfaces of any colour and texture and under various lighting conditions. It can also work with projection screens.

■ ADVANTAGES OVER EXISTING ANALOGUES

SmartWall-based non-electronic interactive surfaces and gadgets have no direct analogues. Among the indirect analogues of the product are any electronic gadgets or devices using sensing technologies (such as interactive boards) which are much more expensive and fragile.

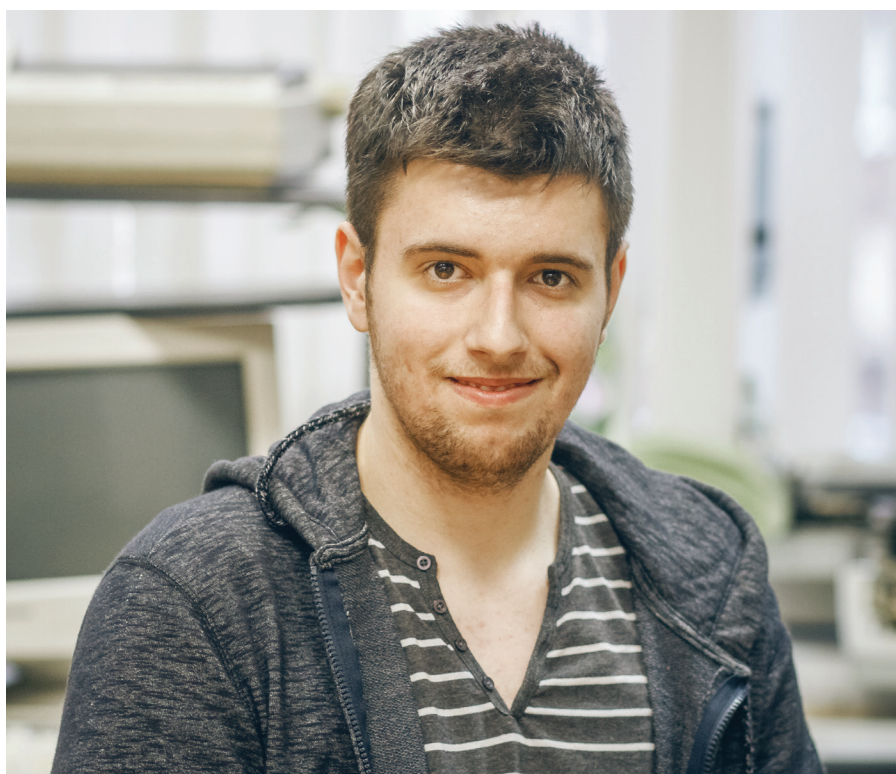
## ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The main potential customers are educational institutions, rehabilitation centres, shopping centres, agricultural enterprises, and individuals.

## ■ STAGE OF PROGRESS

The SmartWall software has been developed as well as the following SmartWall-based products:

- a programme that can binarise and save noisy images either downloaded, or captured by the webcam;
- a programme that allows controlling an audio player using a paper remote controller;
- a concept version of the programme for controlling a computer with one's eyes;
- SmartWallBand application (allows controlling Skype using buttons drawn on a textile bracelet);
- SmartWallBattle application, requiring a projector and a webcam, can be used in interactive quizzes organised by educational institutions. Players touch drawn buttons and the application registers the time of the answer, decides whether it is correct, and keeps track of the team points;
- a concept version of a programme for sensory rooms for children. The programme performs segmentation of images from multiple cameras and on various surfaces;
- entertainment and educational content for small children and children with disabilities.



## ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Mechislav Prinev,*

student at the Faculty of Applied Mathematics, Informatics, and Mechanics of VSU.

## ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

Certificate for the registration of the SmartWall computer program has now been received.

## ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

5,000,000.

## ■ SOURCES OF FUNDING

It is planned to use the income from the sale of the software and to obtain additional financing by participating in grant competitions. It is also planned to obtain financing from the regional budget.



■ PROJECT PRODUCT

The product of the project is a PC application that can increase the resolution (size and detail quality) of several images (or frames) and improve their quality. One of the project's objective is also to develop mobile applications with the same functions.

■ DURATION OF THE PROJECT

2017–2019.

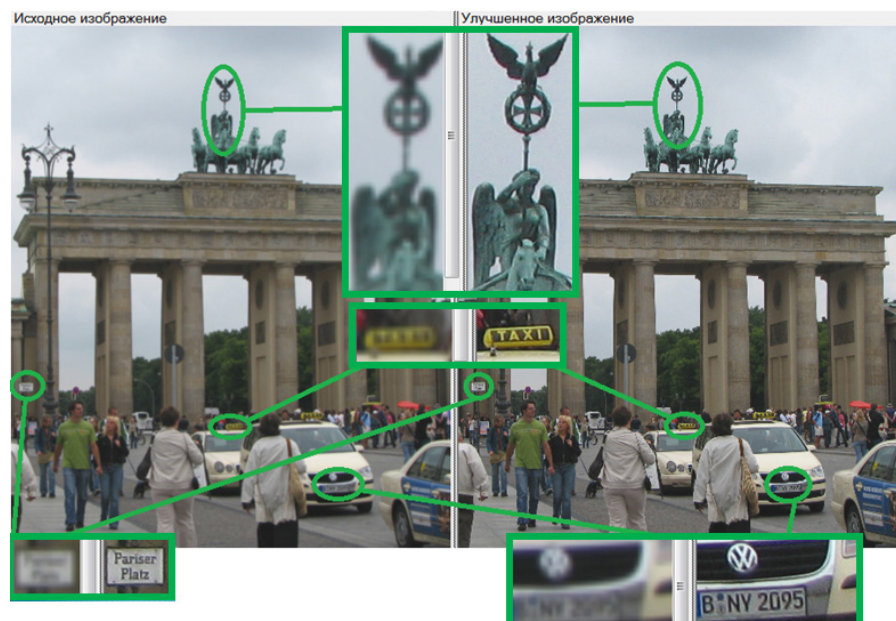
■ PROJECT PAYBACK TIME

About two years.

■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

In 2016, it is planned to submit an application for the computer programmes and database certificate to the Federal Institute of Industrial Property. A GOST P15.011-96 report and a GOST 15.012-84 patent pattern are to be prepared.

## SOFTWARE PACKAGE FOR INCREASING IMAGE AND VIDEO RESOLUTION



Various systems are now being developed in order to register and process optical information. The effectiveness of such systems depend on the quality of the analysed data, which is often presented in digital image and video formats. One of the major requirements to the quality of such images is that they must have high resolution (even the smallest details, such as text or faces, should be recognisable). This requirement is often very difficult to fulfil due to the physical and technical limitations of the equipment used. Another requirement is that any noise appearing after image registration or during its transfer by any communication channel should be compensated for. Such noise can be either additive or applicative (registered images may become corrupted with impulse noise, overlapping areas, etc.).

The proposed software employs new algorithms for increasing the resolution, which improve the quality of the images and eliminate the effect of both additive and applicative noise (overlapping areas, flares, impulse noise, etc.).

■ ADVANTAGES OVER EXISTING ANALOGUES

The major advantage of the proposed software is that it employs new unique algorithms for image processing that help to increase the resolution and eliminate the effects of noise and distortions such as objects overlap, or clouds on air-photography images. It is also possible to perform image processing employing concurrent computing with automated adjustment of the algorithm.

■ STAGE OF PROGRESS

Key algorithms were developed in MATLAB. A prototype of the PC software for image sequence processing was developed. The software is being developed using C# and C++.

The results of the project were presented in 12 papers, including 4 papers included in the Russian Science Citation Index database. A PhD thesis on the topic of the project was successfully defended. The results were also reported at six international conferences.

#### ■ COMMERCIALISATION RISKS

- Lack of financing (15%). Proposed solution - bank loan.
- Failure to meet deadlines (30%). Proposed solution - it is advisable to divide the project in a number of small stages and report to the client upon completion of each step.
- New requirements (40%). Proposed solution - it is advisable to plan and discuss with the client all the required functions and project deadlines in between the project's stages.
- Underestimating other products. New competitors on the market (50%). Proposed solution - specialisation in one field (video only or image only); adjustment of pricing policy.

#### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

The project is of great interest to companies specialising in surveillance systems used for traffic control. Terms of partnership are now being discussed. The research is already being conducted in collaboration with some of the interested companies.

Individuals may also be among the prospective consumers of the product. A number of surveys demonstrated that they would also like to purchase such software to install on their PCs.



#### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

*Alexander Ivankov,*

lecturer at the Department of Information Security and Processing Technologies of the Faculty of Computer Sciences of VSU.

#### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

7,000,000. The major expenditures include the developers' salary and organisation of promotional events.

#### ■ SOURCES OF FUNDING

Among the prospective sources of funding are the Skolkovo Foundation, State Foundation for Assistance to the Voronezh Region Small Innovative Enterprises, Foundation for Developing Internet Initiatives, Russian Venture Company Foundation, inner financing, a VSU-based small innovative business, and grants from the Fund for Promotion of Small Enterprises in Scientific and Technical Field awarded to the participants of such programmes as U.M.N.I.K. and START. Other possible sources are bank loans.

### ■ INFORMATION ABOUT THE PROJECT'S INITIATOR (DEVELOPER)

Laboratory of Medical Cybernetics at the Faculty of Computer Sciences. Supervisor: Ya. Turovsky, lecturer. Implemented by A. Alexeiev, student.

### ■ STAGE OF PROGRESS

A prototype was produced. The software is under revision.

### ■ СРОК ОКУПАЕМОСТИ ПРОЕКТА

2 years.

### ■ DURATION OF THE PROJECT

2 years.

### ■ TOTAL COST (FUNDING) OF THE PROJECT IN ROUBLES

450,000.

### ■ SOURCES OF FUNDING

- Grant received within the framework of the U.M.N.I.K. Programme – 400,000 roubles.
- First place at VSU's competition of innovative projects 2015 – 20,000 roubles.
- Private finances – 30,000 roubles.

## AN EYE-TRACKING SYSTEM

### ■ PROJECT PRODUCT

- A device for taking images of the eye.
- Software for marketing research.
- Software for controlling various devices.
- Software for integration with augmented reality systems.

### ■ ADVANTAGES OVER EXISTING ANALOGUES

- Lower equipment and software cost with the quality being the same.
- Simpler software and equipment tuning process as compared to the existing analogues.
- The software can be used in other systems.
- The software can be used with any equipment that meets key requirements, without quality loss.

### ■ PATENT PROTECTION FOR THE MAIN TECHNOLOGICAL SOLUTIONS OF THE PROJECT

5 computer programmes and data bases certificates were obtained. A utility model patent application is about to be submitted.

### ■ COMMERCIALISATION RISKS

- Lack of demand - the risk level is very low as the results of the project can be applied in various areas.
- Lack of funding - the risk level is low as the project is in its final stage.

### ■ ENTERPRISES THAT MAY BE INTERESTED IN THE RESULTS OF THE PROJECT

- Marketing research companies.
- Rehabilitation centres and institutions for critically ill patients.
- Companies specialising in computer peripherals.
- Research laboratories.

