REVIEW OF NANOTECHNOLOGICAL INVENTIONS

DOI: 10.15828/2075-8545-2020-12-3-140-146
Article type: Review article

Nanotechnologies: a review of inventions and utility models. Part III

L.A. Ivanov[1*], A.V. Demenev[2], Zh.V. Pisarenko[3], Q. Wang[4]
[1] Russian Academy of Engineering, Moscow, Russia
[2] Russian State University of Tourism and Service; Cherkizovo, Moscow region, Russia
[3] Saint-Petersburg State University, Saint-Petersburg, Russia
[4] China University of Petroleum, Qingdao, China
[*] **Corresponding author:** e-mail: L.a.ivanov@mail.ru

ABSTRACT: The article provides an abstract review of patents. The results of creative activity of scientists, engineers and specialists, including inventions in the field of nanotechnology and nanomaterials, being implemented, allow achieving a significant effect in construction, housing and community services, and related sectors of the economy. For example, the invention «Raw mixture for production of fine-grained polymer concrete modified by microsilica» refers to construction and can be used in manufacture of nanomodified concretes based on potentially chemically reactive coarse and/or fine filler for transport, industrial and civil construction. Modification of cement stone structures by means of microsilica made of silica production wastes and acrylic dispersion will make it possible to intensify hydration of binder, to reduce cement consumption and to increase strength characteristics of final product compared to traditional concrete mixtures. The invention can be used to produce concrete articles and structures, flagstones, decorative borders, to arrange top layers of road beds and to repair them when it is required, as well as to fill cracks and as a filler in sealing joints.
The specialists can also be interested in the following inventions in the area of nanotechnologies: nanomodified high-strength light concrete, combined heat-insulating system, composite layered self-healing material, a method to produce metal/carbon nanocomposites, an electrochemical method to produce nanosized powder of metal silicide, a method to produce metal-polymer nanocomposite materials with metal nanoparticles et al.

KEYWORDS: nanotechnologies in construction, fine-grained polymer concrete, nanomodified high-strength light concrete, metal/carbon nanocomposites, nanosized powder.

FOR CITATION: Ivanov LA., Demenev A.V., Pisarenko Zh.V., Wang Q., Nanotechnologies: a review of inventions and utility models. Part III. Nanotechnologies in Construction. 2020, Vol. 12, no. 3, pp. 140–146. DOI: 10.15828/2075-8545-2020-12-3-140-146.

INTRODUCTION

Advanced technologies impress people's imagination demonstrating the latest achievements (materials, methods, systems, technologies, devices etc.) that dramatically change the world. This, first of all, concerns nanotechnological inventions designed by scientists, engineers and specialists from different countries.

MAINPART

Raw mixture for production of fine-grained polymer concrete modified by microsilica (RU 2711169 C1)

The invention refers to construction and can be used in manufacture of nanomodified concretes based on potentially chemically reactive coarse and/or fine filler for transport, industrial and civil construction [1]. The technical result is increased strength, frost resistance and quality of concrete and reduced energy consumption in manufacturing process at the same time. The technical result is achieved due to the fact that raw mixture used in production of fine-grained polymer concrete, modified by microsilica, contains Portland cement M500, nanodispersed additive, sand, polymer (latex), water, according to invention, contains microsilica MK-95 as a nanodispersed additive, acrylic dispersion ВДСМ-КИ-01-01 (latex) as polymer, a mixture of high-silica sand fractions as a filler. Ratio of raw mixture components is given in the table 1.

Modification of cement stone structures by means of microsilica made of silica production wastes and acrylic dispersion will make it possible to intensify hydration of binder, to reduce cement consumption and to increase strength characteristics of final product compared to traditional concrete mixtures. The invention can be used to produce concrete articles and structures, flagstones, decorative borders, to arrange top layers of road beds and to repair them when it is required, as well as to fill cracks and as a filler in sealing joints.

Table 1

Raw mixture components	**mass. %**
Portland cement M500	from 20,8 to 21.0
Microsilica MK-95	from 2,1 to 3,1
Sand, fraction 2,5 - 3 mm	from 62,8 to 63,3
Acrylic dispersion ВДСМ-КИ-01-01 (latex)	from 0,10 to 0,13
Water	from 12,7 to 13,0

Nanomodified high-strength light concrete (RU 2718443 C1)

The invention refers to the industry of construction materials and can be used in manufacture of articles in civil and industrial construction, cast-in-situ construction, erection of special buildings [2]. The technical result is obtaining high-strength light concrete with high module of elasticity and at the same time saved (increased) weight strength. Nanomodified high-strength concrete possesses average density 1300...1510 kg/m^3; compressive strength 50,5...65,8 MPa; weight strength 38,8...43,6 MPa; crack resistance coefficient 0,084...0,085; module of elasticity 6,10...8,22 GPa, Poisson's ratio 0,093...0,136.

The technical result is obtaining high-strength light concrete with high module of elasticity and at the same time saved (increased) weight strength. The technical result is achieved due to the following technology: high-strength light concrete contains Portland cement, filler, plasticizer and water, as well as mineral part that consists of microsilica which average size of particles is 0,01...1 um; rock dust (it is an outcome of grinding silica sand or other rock with silica content) with specific surface area 750 m2/kg and silica sand fraction 0,16–0,63 mm; hyperplasticizers on the basis of polycarboxylate are used as plasticizers; fillers are hollow aluminum silicate microspheres; additionally there is a nanosized modifier on the surface of the hollow microspheres. This nanosized modifier is a colloidal solution of silica sol and ferrum (III) hydroxide sol with particle size less than 30 nm, in which concentration of silicic acid in the form H_2SiO_3 is 3,02%.

To prepare concrete Portland cement, for example, brand CEM I 42,5 N according to GOST 31108-2003 is used. Mineral part that contains graded silica sand (fr. 0,16–0,63 mm) according to GOST 8739-93, rock dust with specific surface 750 m^2/kg and microsilica provide filling of intergranular openings of filler, forming dense structure.

Aluminum silica full microspheres are used as a filler as their characteristics decreases average density. These microspheres are carriers of nanomodifier, that makes it possible, on the one side, to distribute it in the volume of composite, on another side – to use chemical activity of its components locally, in phase boundary «cement stone – microsphere».

A method to produce silicone dioxide capsules on the surface of inorganic nanoparticles (RU 2715531 C2)

The invention refers to the area of composite nanomaterials. A method to produce material that contains silicone dioxide capsules on the surface of inorganic nanoparticles has been developed [3]. The method involves chemical precipitation of silicone dioxide from sodium metasilicate solution that contains inorganic nanoparticles. Nanoparticles are dispersed in water under ultrasound impact, sodium metasilicate with concentration 0,001–0,1 mol/liter is introduced into suspension of aqueous solution, when mixing hydrochloric acid solution is added if concentration and volume of hydrochloric acid solution is equal to concentration and volume of sodium metasilicate solution. Then all that is cured under 8 hours mixing, centrifugated, washed out and dried.

The obtained technical result is the possibility to produce silicone dioxide capsules on the surface of inorganic nanoparticles in aqueous suspension using method of chemical precipitation from the solution. Sodium metasilicate dissolved in aqueous phase of suspension of nanoparticles involved in precipitation is used as a precursor for obtaining silicone dioxide capsules. Thickness of silicone dioxide layer can vary in dependence of process parameters, from several units to hundreds of nanometers. Nanoparticles of inorganic compounds of metals of different shape can be used as cores.

Combined heat-insulating system (RU 2717456 C1)

The invention refers to combined heat-insulating systems and to the methods to install them [4]. Combined heat-insulating system possesses insulation layer, not necessary reinforcing one, applied on insulation layer, and an external layer applied on insulation layer or on reinforcing layer if it is available. The system differs in a way that an external layer contains composite particles that possess at least one organic polymer as organic polymer phase and at least one inorganic hard substance which particles are distributed in organic polymer phase. At this mass fraction of inorganic hard substance is from 15 to 40 mass.% calculated as total mass of organic polymer and inorganic hard substance in composite particle, and the size of composite particles is from 5 to 5000 nm. The method of thermal insulation of outer facades provides for installing mentioned above heat-insulating system on the outer façade. Application of composite particles as composite covering dispersion which size is 5–5000 nm and contain at least one organic polymer as organic polymer phase and at least one inorganic solid substance which particles are distributed in organic polymer phase, when building mentioned above combined heat-insulation systems. Technical result is increased mechanical loading – shock resistance, formation of stable barrier and saved shock resistance.

Composite layered self-healing material (options) (RU 2710623 C1)

The invention refers to layered composites (options) that are able to restore independently its integrity after caused mechanical damages (self-healing ability). The layered composites are used to manufacture structures that are needed to be protected from defects, in particularly, to manufacture structures with inner atmosphere, for example, for hermetic objects [5]. In the first option a composite layered self-healing material contains two external flexible layers and a composite layer. The composite layer consists of organosiloxane matrix and a filler. There is a layer of boron-siloxane oligomer and polymer between composite layer and external flexible layer. At the same time external flexible layers comprise material similar to organosiloxanes. In another option composite material contains two composite layers and two flexible external layers. The first composite layer connects to the first external flexible layer, and the second composite layer connects to the second external flexible layer. External flexible layers involve material similar to organosiloxanes. In another option composite material contains two composite layers and two flexible external layers. There are two layers on the basis of boron-siloxane oligomer or polymer separated by bound layer between two composite layers. External flexible layers also comprise material similar to organosiloxanes.

The technical result of the invention is the ability of composite layered materials to self-heal for the short time, within the order of several seconds, with long-lasting healing effect. The proposed structures of layered self-healing composite material could provide both self-healing properties and required phisicomechanical characteristics that allow using these structures under extreme conditions, for example, when protection from damages is needed or urgent repair is impossible or delayed.

A method to produce metal/carbon nanocomposites (RU 2715655 C2)

The invention refers to the industry, construction, agriculture, medicine and can be used in production of catalysts, active additives and agents [6]. 3d metal oxide used as a metal-containing substance and polyvinyl alcohol with molecular mass no more than 80 000 are mechanochemically mixed in triturating machine spending energy no less than 220 kJ/mole until oxidation-reduction process starts. Then obtained xerogel is stage heated until formation of nanogranular that involves metal-containing clusters with the size up to 50 nm, associated with carbon coating on which delocalized electrons are determined. Ratio of components is 2–4 moles of polyvinyl alcohol to 1 mole of copper oxide, or 3–6 moles of polyvinyl alcohol to 1 ferrum oxide, or 4–6 moles of polyvinyl alcohol to 1 mole of nickel oxide.

The technical effect of the invention is a method to produce metal/carbon nanocomposites with specified atomic magnetic moment of 3d metal in nanocomposite that exceeds atomic magnetic moment of the 3d metal crystal and possesses high chemical activity.

A method of electrochemical obtaining nanosized powder of metal silicide (RU 2718022 C1)

The invention refers to obtaining nanosized powder of metal silicide. An electrolyte consisting of alkali metal halide and metallic salt and consumed micron sized components in the form of metal and silica powders are placed into hermetic crucible and are heated to the temperature of metal silicide synthesis above electrolyte melting point with obtaining ion melt in argon or carbon dioxide [7]. To transfer metal to silica in ion melt with formation of nanosized powder of metal silicide, it is necessary to provide anionic and cationic composition of ion melt with electrochemical potential of metal, which is more negative than silica potential, by value >0,5 V. Hardened electrolyte with formed powder is extracted from the crucible, grinded and exposed to hydrometallurgical treatment with obtaining nanosized powder of metal silicide. That provides electrochemical obtaining of nanosized powder of metal silicide.

It is also possible to use powders of metal and silica of micron size as consumed components with further heating up to process temperature above electrolyte melting point in hermetic crucible in argon or carbon dioxide atmosphere. That allows obtaining ion melt in which electrochemical transport reaction by means of target spontaneous transfer of metals as well as silica by their ions through ion melt without electrolysis makes it possible to perform synthesis of metal silicide powder with specified size. Running of electrochemical transport reactions in ion melt leads to transition of metal and silica into the melt and controlled maintenance of anionic and cationic composition of ion melt in dependence of electrochemical potentials ratio of metal and silica leads to transfer of metal to silica, that allows obtaining powders of metal silicide of specified size. When silica is transferred to metal the mechanism of synthesis is the same one used in industrial technologies, that allows performing synthesis of powders of metal silicide of micron sizes.

A method to obtain ultrapure hydrogen by steam reforming of ethanol (RU 2717819 C1)

The invention refers to the area of catalyst and reactors development for chemical and petrochemical industry, in particular to processes of dehydration and steam reforming of lower aliphatic alcohols to obtain ultrapure hydrogen, suitable for use in fuel cells [8]. A method involves introduction of mixture of ethanol and water steam into membrane-catalytic reactor, steam reforming of ethanol under increased temperature on metal-containing catalyst with simultaneous removal of formed ultrapure hydrogen through water selective membrane of palladium-containing alloy such as permeate, blowing-off of ultrapure hydrogen with gas-carrier and retentate removal. At this alloy of 93,5 mass.% Pd, 0,5 mass.% Ru, 6,0 mass.% In is used as Palladium-containing alloy, and an alloy selected from Pd–Ru and Pt–Ru if the content of the second element is 10 mass.% and applied on powders of detonative nanodiamonds is used as a catalyst. Steam reforming of ethanol is performed under temperature 380–650°C and pressure 1–3 atm with removal of retentate as additional product – hydrogen-containing gas. The technical result is increased output of hydrogen suitable for application on fuel cells and simultaneous softening of reaction conditions as well as increased membrane operating life.

Bubble electrospinning device (CN208309015U)

The utility model discloses a bubble electrospinning device, including gear motor, receive roller, high voltage power supply, solution tank, still include pump, pressure dissolved air vessel, air compressor, distributor and feed tank, the distributor is installed in the solution tank bottom, installs the release head on the distributor, receives the roller setting and directly over solution tank,receives the axle of roller and gear motor's hub connection, the receipt roller passes through wire ground connection, the anodal of high voltage power supply is connected bottom the distributor, thepressure dissolved air vessel top is connected bottom feed tank through the import pipeline, is equipped with the pump on the import pipeline, and the pressure dissolved air vessel bottom is connectedwith the distributor through the export pipeline, and the outlet pipe is equipped with manometer, valve and flowmeter on the road, and pressure dissolved air vessel passes through in the lower rightcorner gas -supply pipe and is connected with air compressor. The utility model discloses an adopt pressure gas dissolving's mode to dissolve the mode gassing that stepped down and release in the backin the feed liquid with the air, the bubble volume of production is small, has effectively reduced the nanofiber's of production diameter. [9].

Filtering material based on a layer of polymer nanofibers and spinning solution to produce it (RU 2718786 C)

The technical result of the family of inventions is the achieved efficiency of filtering from dust microparticles with size 0,3–0,4 μm and aerosols within the range 85–95% under high air permeability 180...250 mm/sec, under 200 Pa and durability of filter material as well as reliable joint between polymer nanofiber (nanomembrane) and prefilter dust accumulator that allows goffering of filter material without break of large fabric and doesn't allows membrane flaking from prefilter.

The set technical problem and technical result are achieved due to the following mechanism. According to the first invention, to produce polymer nanofiber in spinning solution that contains a mixture of two polymer materials at least in organic solutions by means of capillar-free electroforming, one of the polymer materials, which is a binder, should have softening temperature lower than that of the rest polymer materials. Additionally, the mixture contains surface active agent, foam suppressant and viscosity stabilizer, and surface active agent can be polyethyleneglycol mono (tetramethylbutanol) phenyl ether or poluoxiethylensorbitan monooleate or a mixture of mono- and diethers of phosphoric acid and ethoxylated alcohols, ratio of components is given in the table 2:

Table 2
Mixture components ratio

Components	**mass. %**
Polymer materials	from 8 to 15
Polyethyleneglycol mono (tetramethylbutanol) phenyl or polyoxyethylene sorbitan monolayrate or mixture of mono- and diester of phosphoric acid and ethoxylate alcohols	from 0,15 to 0,25
Foam suppressor	from 0,1 to 0,15
Viscosity stabilizer	from 0,05 to 0,10
Organic solvent	the rest

Preparation method of cathode material LiVPO4F for nanofibrous lithium ion battery (CN108821256A)

The invention relates to a preparation method of cathode material LiVPO4F for a nanofibrouslithium ion battery, and belongs to the technical field of lithium-ion batteries. The specific preparation method of the LiVPO4F material is as follows: adding a lithium source, a vanadium source, a fluorine source, a phosphorus source, a reducing agent and a coated carbon source into an organic solvent according to proportions to form mixed liquid; then heating and stirring the mixed liquid to enable V<5+> to be quickly and completely reduced into V<3+> and forming a green solution; setting the operating voltage and feeding speed of electrostatic spinning equipment and then carrying out electrostatic spinning to obtain a nanofibrous LiVPO4F precursor; finally, putting the nanofibrous LiVPO4F precursor in an non-oxidizing atmosphere for carrying out high temperature sintering and naturally cooling to room temperature, thus obtaining the nanofibrous LiVPO4F cathode material. The preparation method disclosed by the invention has the advantages of simplicity, short process flow, easiness in control and facilitation of industrialization; the obtained material has special morphology of an intersected three-dimensional nanofibrous shape, so that the electrochemical property of the material is significantly improved [11].

A plant to produce nanostructured composite multifunctional coatings made of detail surface shape memory material (RU 2718785 C1)

The invention refers to the plant to produce nanostructured composite multifunctional coatings made of detail surface shape memory material [12]. The technical result of the invention is prolonged service life of the plant. Prolonged service life of the plant is achieved due to additional powder dose mechanical activator fixed on the frame and jointed to vacuum camera box of diffusion pump. The powder dose mechanical activator is rigidly fixed in cooling hood. The powder dose mechanical activator contains metal mixer connected to electric motor installed in the upper part of the mechanical activator. The lower part of the mechanical activator which is connected to flame burner by means of transport line of the shape-memory effect powder contains metal grading screen in which hole size is 5 μm. One side of the middle part of the body of powder dose mechanical activator is fixed on the side surface of control unit by means of two fasteners and adapter sleeve used to supply inert gas is connected to gas bottle containing inert gas. The opposite side of powder dose mechanical activator contains another adapter sleeve connected to vacuum pump with vacuum tube.

The installation of the powder dose mechanical activator to grind sprayed shape-memory effect powder makes it possible to eliminate oxidation process for sprayed material due to mechanical activation, grinding and sifting (with grading screen) with instant and simultaneous supply of it into gas-flame burner for spraying. All that decreases probability of formation of conglomerate of multicomponent powders which often clog flame burner and as a result that leads to impossibility to spray (rubber burning-out in flame burner) and to shortened service life of it.

The specialists can also be interested in the following inventions related to nanotechnologies:

- A method to produce metal-polymer nanocomposite materials with metal nanoparticles [13].
- A method to obtain nanostructured composite material on the basis of aluminium [14].
- A method to obtain film copper-containing nanocomposite materials for protection of metal products from corrosion [15].
- A method to produce fireproof wood-polymer composites on the basis of secondary polyolefine [16].
- A method to evaluate aggregation of nanoparticles in colloidal solutions [17].
- Symmetric four-pair cable with film-nanotube and micro-tube perforated cable-core insulation [18].
- Construction structural element [19].
- A coating with low reflectivity, a method and a system for covering base plate [20].
- Bright monomeric near-infrared (NIR) fluorescent proteins (FPs) as protein tags for multicolor microscopy and in vivo imaging [21].
- Discovery of new properties of well-known magnetic materials. This is particularly noticeable in the case of heavy rare earth metals, where a high degree of purity and absence of impurities can lead to the appearance of new magnetic phases and phase transitions [22].
- Elastic conductive film on the basis of silver nanoparticles [23].
- Electrostatic spun nanofibrous membrane of controlled-release growth factors and esophageal membrane-coated memory stent [24].

CONCLUSION

One of the most challenging tasks the economy of every country face is to increase industrial competitiveness through technological upgrade. From the side of the state and companies the principal object to control in this process are the people and enterprises dealing with introduction of inventions and new technologies.

Therefore, we hope that the information published in this section will be in demand and useful for specialists.

REFERENCES

1. Balabanov V.B., Putsenko K.N. Patent 2711169 RF C1. Raw mixture for production of fine-grained polymer concrete modified by microsilica. 2020. Bul. No. 2. (In Russian)
2. Inozemtsev A.S., Korolev E.V. Patent 2718443 RF C1. Nanomodified high-strength light concrete. 2020. Bul. No. 10. (In Russian).
3. Yurtov E.V., Sertsova A.A., Marakulin S.I., Dobrovolsky D.S. Patent 2715531 RF C2. A method to produce silicone dioxide capsules on the surface of inorganic nanoparticles. 2020. Bul. No. 7. (In Russian)
4. Khashemadze A., Asbek P., Tse Kh., Binert Kh. Patent 2717456 RF C1. Combined heat-insulating system. 2020. Bul. No. 9. (In Russian)
5. Sitnikov N.N., Khabibulina I.A., Rizakhanov R.N. Patent 2710623 RF C1. Composite layered self-healing material. 2019. Bul. No. 1. (In Russian)
6. Kodolov V.I., Trineeva V.V., Mustakimov R.V. et al. Patent 2715655 RF C2. A method to produce metal/carbon nanocomposites. 2020. Bul. No. 7. (In Russian)
7. Leontiev L.I., Lisin V.L., Petrova S.A. et al. Patent 2718022 RF C1. an electrochemical method to produce nanosized powder of metal silicide. 2020. Bul. No. 10. (In Russian)
8. Mironova E.Yu., Ermilova M.M., Orekhova N.V., Yaroslavtsev A.B. Patent 2717819 RF C1. A method to obtain ultrapure hydrogen by steam reforming of ethanol. 2020. Bul. No. 9. (In Russian)
9. Guojun J., YIBO, J.; DONG, NI. Bubble electrospinning device CN208309015U. [英文]. Zhijiang College Of Zhejiang Univ Technology. 2018.06.04.
10. Khrustitsky V.V., Khrustitsky K.V., Kossovich L.Yu. Patent 2718786 RF C1. Filtering material based on a layer of polymer nanofibers and spinning solution to produce it. 2020. Bul. No. 11.
11. Changling, F., Weihua, ZH., Zheng, W., QIyuan, LI, Shaochang, H. Preparation method of cathode material LiVPO4F for nanofibrous lithium ion battery. CN108821256A. [英文]. University of Hunan. 2018.06.24.
12. Rusinov P.O., Blednova Zh.M. Patent 2718785 RF C1. A plant to produce nanostructured composite multifunctional coatings made of detail surface shape memory material. 2020. Bul. No. 11.
13. Ivanov LA., Kapustin I.A., Borisova O.N., Pisarenko Zh.V. Nanotechnologies: a review of inventions and utility models. Part II. Nanotechnologies in Construction. 2020, Vol. 12, no. 2, pp. 71–76. DOI: 10.15828/2075-8545-2020-12-2-71-76.
14. Bagramov P.X., Evdokimov I.A. Patent 2716965 RF C1. A method to obtain nanostructured composite material on the basis of aluminium. 2020. Bul. No. 8. (In Russian).
15. Dzhardimalieva G.I., Kydralieva K.A., Kurochkin S.A. et al. Patent 2716464 RF C1. A method to obtain film copper-containing nanocomposite materials for protection of metal products from corrosion. 2020. Bul. № 8. (In Russian).
16. Ivanov LA., Razumeev K.E., Bokova E.S., Muminova S.R. The inventions in nanotechnologies as practical solutions. Part V. Nanotechnologies in Construction. 2019, Vol. 11, no. 6, pp. 719–729. DOI: 10.15828/2075-8545-2019-11-6-719-729.
17. Alenichev M.K., Drozhennikova E.B., Levin A.D., Nagaev A.I. Patent 2714751 RF C1. A method to evaluate aggregation of nanoparticles in colloidal solutions. 2020. Bul. No. 5. (In Russian).
18. Portnov E.L. Patent 2714686 RF C1. Symmetric four-pair cable with film-nanotube and micro-tube perforated cable-core insulation. 2020. Bul. No. 5. (In Russian).
19. Ivanov LA., Prokopiev P.S. The inventions in nanotechnologies as practical solutions. Part III. Nanotechnologies in Construction. 2019, Vol. 11, no. 3, pp. 292–303. DOI: 10.15828/2075-8545-2019-11-3-292-303.
20. March N.U., Shan Dr. N., Bustos-Rodrigues S., Yensen B.P., Crossley O. Patent 2717561 RF C2. A coating with low reflectivity, a method and a system for covering base plate. 2020. Bul. No. 9. (In Russian).
21. Matlashov, M.E., Shcherbakova, D.M., Alvelid, J.b, Baloban, M., Pennacchietti, F.b, Shemetov, A.A., Testa, I. A set of monomeric near-infrared fluorescent proteins for multicolor imaging across scales. – Nature Communications. – 11(1).239. – 2020. – DOI: 10.1038/s41467-019-13897-6.
22. Gimaev, R.R., Zverev, V.I., Mello, V.D. Magnetic properties of single-crystalline terbium and holmium – Experiment and modeling Journal of Magnetism and Magnetic Materials. – Vol. 505. – July, 2020. – DOI: 10.1016/j.jmmm.2020.166781.
23. Ivanov L.A., Demenev A.V., Muminova S.R. The inventions in nanotechnologies as practical solutions. Part II. Nanotechnologies in Construction. 2019, Vol. 11, no. 2, pp. 175–185. DOI: 10.15828/2075-8545-2019-11-2-175-185.
24. Xinjian W., Weixing, ZH. Electrostaticspun nanofibrous membrane of controlled-release growth factors and esophageal membrane-coated memory stent. CN109172073A. [英文]). 2018.09.03.

INFORMATION ABOUT THE AUTHORS

Leonid A. Ivanov, Cand. Sci. (Eng.), Vice President of the Russian Academy of Engineering, Member of the International Journalist Federation; Moscow, Russia, ORCID: https://orcid.org/0000-0001-9513-8712, e-mail: L.a.ivanov@mail.ru

Aleksey V. Demenev, Cand. Sci. (Eng.), Assistant Professor, Higher school of service, Russian State University of Tourism and Service; Cherkizovo, Moscow region, Russia, ORCID: https://orcid.org/0000-0002-1573-6665, e-mail: saprmgus@mail.ru

Zhanna V. Pisarenko, Doctor of Economics, Assistant Professor, Saint-Petersburg State University, Economic Faculty, Department of Risk Management and Insurance, Saint-Petersburg, Russia, ORCID: https://orcid.org/0000-0002-9082-2897, e-mail: z.pisarenko@spbu.ru

Qiang Wang, Doctor of Environmental Science, Professor, China University of Petroleum, Management Faculty, Department of Management Science, Qingdao, Shandong People's Republic of China, ORCID: https://orcid.org/0000-0002-8751-8093, e-mail: wangqiang7@upc.edu.cn

All authors declare the absence of any competing interests.

Received: 27.04.2020.
Revised: 22.05.2020.
Accepted: 28.05.2020.