УДК 69

НАНОТЕХНОЛОГИИ В СТРОИТЕЛЬСТВЕ
V Международная научно-практическая on-line конференция

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V МЕЖДУНАРОДНАЯ НАУЧНО-ПРАКТИЧЕСКАЯ ONLINE-КОНФЕРЕНЦИЯ «ПРИМЕНЕНИЕ НАНОТЕХНОЛОГИЙ В СТРОИТЕЛЬСТВЕ»

(15–16 МАЯ 2013 г.)

THE V INTERNATIONAL THEORETICAL AND PRACTICAL ONLINE-CONFERENCE «APPLICATION OF NANOTECHNOLOGIES IN CONSTRUCTION INDUSTRY»

(15–16 MAY 2013)

Интернет-портал NanoNewsNet (www.nanonewsnet.ru) и электронное издание «Нанотехнологии в строительстве: научный Интернет-журнал» (www.nanobuild.ru) совместно провели V Международную научно-практическую online-конференцию «Применение нанотехнологий в строительстве». В ней приняли участие ведущие ученые и специалисты Российской академии наук, Российской инженерной академии, Российской академии архитектуры и строительных наук, РОСНАНО, Научно-технического центра прикладных нанотехнологий (г. Санкт-Петербург), Международной инженерной академии, Международного союза экспертов и лабораторий по испытанию строительных материалов, систем и конструкций (РИЛЕМ), руководители и специалисты организаций и предприятий, ученые, преподаватели вузов, сотрудники НИИ и научных центров из различных регионов России, стран ближнего и дальнего зарубежья.

Internet-portal NanoNewsNet (www.nanonewsnet.ru) and electronic edition «Nanotechnologies in Construction: A Scientific Internet-Journal» (www.nanobuild.ru) jointly held The V International Theoretical and Practical Online-Conference «Application of Nanotechnologies in Construction Industry». Russian leading scientists and specialists of Russian Academy of Sciences, Russian Academy of Engineering, Russian Academy of Architecture and Construction Sciences, ROSNANO, Scientific and Technical Center of Applied Nanotechnologies (Saint-Petersburg), International Academy of Engineering, International Union of Experts and Laboratories on Testing Construction Materials, Systems and Structures (RILEM), chiefs and specialists of different organizations and enterprises, scientists, lecturers of universities, research officers of scientific institutions from different Russian regions and foreign countries took part in this online-conference.

Ключевые слова: online-конференция, нанотехнологии в строительстве, нанопокрытия, наноструктурирование, нанодобавки, нанодисперсные эмульсии и суспензии, наномодификаторы, нанотрубки, наноизоляционные покрытия.

Key-words: online-conference, nanotechnologies in construction, nanocoatings, nanostructuring, nanoadditives, nanodispersed emulsions and suspensions, nanomodifiers, nanotubes, nanoisolation coatings.

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SOBOLEV Konstantin Gennadievich, Associate Professor of University of Wisconsin-Milwaukee, USA, Chairman of Technical Committee ACI 236D on nanotechnologies in concrete of American Concrete Institut

ФАЛИКМАН Вячеслав Рувимович, Национальный делегат РИЛЕМ в РФ, член Бюро РИЛЕМ, первый зам. председателя ТК 465 «Строительство» Росстандарта, профессор МГСУ
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The V International Theoretical and Practical Online-Conference «Application of Nanotechnologies in Construction Industry» was organized in the following way. Organizers launched the procedure of on-line-conference. The visitors of the web sites (**www.nanonewsnet.ru** and **www.nanobuild.ru**) asked participants questions by e-mail (**info@nano-build.ru** or **empirv@mail.ru**). Organizing committee summarized all the questions and sent them to participants. We are glad to present you the participants' answers given to the visitors of our websites.

GUSEV Boris Vladimirovich,
Editor-In-Chief of Electronic Edition «Nanotechnologies in Construction: A Scientific Internet-Journal»,
President of Russian Academy of Engineering and International Engineering Academy, Co-chairman of the Higher Engineering Council of Russian Federation,
Corresponding Member of RAS, Expert of RUSNANO,
Doctor of Engineering, Professor

As the participants of the conference have already answered to the questions concerning application of nanomaterials and nanotechnologies in construction in detail, I as the editor-in-chief of the electronic edition «Nanotechnologies in Construction: A Scientific Internet-Journal» would like to reply explicitly to the questions addressed to the editors.

5. It is the fifth time when the Internet Journal «Nanotechnologies in Construction» holds the online conference «The Application of nanotechnologies in construction industry». That is really great as every year specialists from different construction areas can ask questions and get answers from domestic and foreign experts. Moreover, the materials of the conference are available through different Internet resources, That increases the number of specialists who are able to get access to them. I'm grateful to the conference organizers for their work. But don't the editors plan to conduct the conference internally? To my mind, that would allow us to discuss the problems of nanotechnology development in more effective ways, as well as to establish business connections.

V. Karpov, Doctor of Engineering

Dear Mr.Karpov!

Thank you for your high rating of the online-conference «Application of Nanotechnologies in Construction Industry» which was already held 5th time. For the last years it became «beacon» in some sense in the area of construction nanotechnologies. The readers always expect the conference's resuts and write the letters with question to the editors. The editors are constantly improving the ways for conference realization. One should note that today this form of carrying out such events is getting more and more popular and is used in different sectors of economics in our country and abroad. It is true that to hold conference internally would allow us to discuss the problems more efficiently, to establish new business ties. The only problem – financing. If the sponsors will come soon, we are ready to consider the opportunity to organize such event, and taking into account the experience of Russian and International Academies of Engineering, we will do our best. Moreover I and rector of MSUCE Prof. Telichenko are co-chairmen of the II International and III All-Russian conferences on concrete and reinforced concrete which is held under the slogan «Concrete and Reinforced Concrete – the Sight into Future». We hope that one session will be completely devoted to nanotechnological problems.

16. According to recent publications the location of contributors to the Internet Journal «Nanotechnologies in Construction» has widened. The journal became international. That positively affects the content of the journal, but at the same time there are no foreign scientists and experts among the editors. Is it the policy of the editors?

N. Krotov, Doctorate

Dear Mr.Krotov!

In fact Internet-Journal «Nanotechnologies in Construction» is more and more spreading, the number of international events in which the edition takes part and which it supports is also increasing. These are: International «Cement Trade Conference» (Turkey, Istanbul), International Skolkovo Summit for Creators of Innovative Economics, International Forum on Nanotechnologies RUSNANOTECH (Russia, Moscow), 4th International Symposium on Nanotechnology in Construction NICOM4 (Greece, Agios Nikolaos), 3 ensign construction exhibitions in 2013 – BATIMAT, INTERCLIMA+ELEC and IDEO BAIN (France, Paris) et al. That resulted

in expansion of geography of authors and rise of the barest necessity to consult them on their publications. Therefore having responded the editors' call, the leading scientists and experts (which have been cooperating with our edition for a long time) kindly agreed to become the part of the editorial council and editorial board and to work with them:

FIGOVSKY Oleg L'vovich, full member of European academy of Science, forein member of REA and RAABS, Editor-in-Chief of SITA, OCJ and RPCS, Director of «Nanotech Industries, Inc.», USA, and Director of International nanotechnological R&D Center «Polymate» (Israel).

Prof. Peter J.M. BARTOS, The Queen's University of Belfast, UK, Chair of RILEM Technical Committee TC 197-NCM on Nanotechnology in Construction Materials (2002–2009), former Head of Scottish Centre for Nanotechnology in Construction Materials (University of West Scotland);

SOBOLEV Konstantin Gennadievich, Chairman of Technical Committee ACI 236D on nanotechnologies in concrete, Associate Professor of University of Wisconsin-Milwaukee (USA).

TELICHENKO Valerij Ivanovich,
Doctor of Engineering, Professor, Member of Russian Academy of Architecture and Construction Science,
Rector of Moscow State University of Civil Engineering (National Research University)

3. Is there a training course for those specialists who will be employed in production of materials and articles with the use of nanotechnologies? Where and how is this course led?

S. Bonov, technologist (Ukrain)

About forty Russian institutes provide training of the specialists for different areas of nanoindustry. As a rule these are scientific departments attached to educational institutes or RAS departments. In particular Moscow State University of Civil Engineering and Belgorod State Technological University train specialists who will be engaged in production of nanomodified construction materials and articles made of these materials.

The scientific department – Research and Educational Center «Nanotechnology» – which was established at our university and focuses on nanotechnologies directs its effort not only to development of new construction materials (though this is a priority task) but also to training of innovation oriented specialists for the construction industry.

In close cooperation with the representatives of natural science chairs (physics, general chemistry) the following documents were elaborated: educational schedule and normative documents of the disciplines for master program «Nanomodified construction composites of general and specific purpose». Since 2012/13 the lectures are being delivered and laboratory works are being carried out. Specialized tutorials and teaching aids for laboratory works executed on the up-to-date equipment are being prepared for publishing.

We give great attention to students' contingent formation. There are natural-science and applied study groups acting within the frame of the research and educational center. Specialists and bachelors taking part in these groups later will continue their education in the magistracy. Many today's masters are those who earlier did educational or practical work in the research and educational center.

6. What higher educational institutions are training (planning to train) specialists in the area of nanotechnologies in construction? When will the first graduates be? Will they be engaged in the scientific activities?

V.Karpov, Doctor of Engineering

On the 1st July, Saint-Petersburg held meeting of the rectors of the universities – members of the National Nanotechnological Network (NNN) – which gave great attention to the problems of specialist training for nanotechnologies. Among thirty-six participants of NNN who have presented the information about their activities there are only nine participants who are executing educational programs concerning material science and nanomodified composite materials technology. These are: Moscow State University of Civil Engineering, Perm National Research Polytechnic University, National Research University Belgorod State University, National University of Science and Technology «MISIS», National Research University of Electronic Technology, Saratov State University named after N.G. Chernyshevsky, M. K. Ammosov North-Eastern Federal University, Tomsk Polytechnic University, Ufa State Aviation Technical University.

Apart from the leading construction university – MSUCE – no NNN participants stated above directly train specialists for construction engineering. Therefore it is MSUCE who plays the key role in the training of such specialists.

The first group of specialists will graduate in 2014. Many of them are willing to continue education in the post-graduate courses by the specialty 05.23.05 «Construction materials and articles». Being post-graduates they will take active part in the work of Research and Educational Center «Nanotechnology», MSUCE.

Specialists of scientific and innovative educational center «Nanosystems in Construction Material Science», Belgorod State Technological University, mark that in 2012 they certified educational module «The bases of nanotechnologies in construction». However this module was performed in the form of distance education. In our opinion, such educational method is not as efficient as that based on the practice studies in laboratories equipped with the up-to-date tools.

17. How are the specialists in the area of nanotechnologies in construction abroad trained (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)?

B. Zotova, lecturer

Abroad the training of the specialists for nanotechnologies is mainly held in the laboratories (scientific and research centers / design offices; R&D center) established at industrial plants. The equipment of these laboratories is generally corresponding to the equipment of the best domestic scientific and educational centers of the same specialization.

One needs to meet rigid requirements being employed by such laboratories. The necessary condition is the knowledge of natural science disciplines (physics, general chemistry), solid-state physics, optics, physical chemistry, interface and colloid science, electrochemistry, mineralogy and crystallography, physical and chemical research methods (Small- and Wide-angle X-Ray scattering, electronic microscopy, scanning probe microscopy, DTA and DSC, chromatography, FTIR and Raman spectroscopy), mathematics and information technologies. As a rule PhD degree is not obligatory, but once you are doctorate that increases your chances for employment.

KALYUZHNIY S.V.,
Member of the Board of Directors of «RUSNANO»,
Advisor to CEO – Chief Scientist,
PhD, Dr.Sci. (Chemistry), Professor

7. How is the RUSNANO cooperating on realization of nanoindustry development policy?

N. Grotko, expert

Dear Mr. Grotko!

According to RUSNANO's strategy till 2020 approved on 11.06.2013, the mission of the Group of companies RUSNANO is to create nanoindustry in the Russian Federation. In this process RUSNANO's role is the global Russian technological investor who specialized in investments (direct as well as through investment funds of nanotechnologies) in competitive Russian and foreign companies implementing prospective nanotechnologies. These are the main RUSNANO's activities:

- investments in Russian companies implementing prospective nanotechnologies and possessing significant potential to create new advanced technology products markets or to expand the existing ones in Russian Federation;
- investments in foreign companies implementing prospective nanotechnologies to transfer the advanced technologies and to establish new advanced technology productions, research and engineering centers and/or to build technological chains which provide production development in the nanoindustrial area in the Russian Federation.

Today RUSNANO is financing 92 investment projects which total budget is more than 400 milliard rubles (the RUSNANO's share is more than 150 milliard rubles). In 2012 the total sales volume of the nanotechnological products issued by the RUSNANO's project companies was about 25 milliard rubles. The strategic target of RUSNANO is to increase the sales volume of nanoindustrial products up to 300 milliard rubles in 2015.

In addition to investment activities the Group of companies RUSNANO is creating the infrastructure for nanoindustry development. For

that 11 nanotechnological centers in Moscow, Zelenograd, Dubna, Troitsk, Kazan, Novosibirsk, Tomsk, Ulyanovsk, Saransk, Saint-Petersburg, Stavropol, Sarov, 3 engineering companies and 6 other infrastructure centers have been established. Moreover the Fund of Infrastructural and Educational Programs of RUSNANO jointly with the key industrial consumers, ministries and departments, constituent units of the Russian Federation, manufactures of nanotechnological products is performing industrial and regional programs to stimulate demand for nanoindustrial products. The works carried out in 2012 resulted in formation of regional and industrial markets of innovative products including nanotechnological ones which total volume is more than 57 milliard rubles.

Another important task of the Fund of Infrastructural and Educational Programs of RUSNANO is to assist production companies in training and retraining of the staff as well as to cooperate on formation of the market of qualified engineers and managers for nanoindustry. By the mid of 2013 on request of the companies and with the help of the Fund more than 90 programs aimed at training and retraining of nanoindustrial technological and administrative companies' employees have been elaborated.

In addition the Fund initiated the creation of interindustrial communicative platform to discuss the most Important problems concerning nanoindustry development – the Congress of Nanoindustrial Enterprises. The Fund's Department of Education Programs has developed and is performing a range of the programs aimed at popularization of nanotechnologies among students and pupils. The entertaining exhibition «Look, this is NANO!» is the example of these programs.

11. Mass media reported on the creation of a new production of a composite nanostructured polymer reinforced with basalt fibers in Cheboksary. This material is not affected by corrosion. It is as strong as steel but it has a higher resistance to wear. What is your opinion on that?

S. Baranov, the head of construction company

Dear Mr. Bogdanov!

Such production really exists – this is RUSNANO portfolio company «Galen». The product portfolio includes four types of products to be used in construction, mining and road-building. These products are flexible connections inside the buildings' walls, shaft lining, construction reinforce-

ment and light footings. Construction reinforcement by «Galen» possesses increased corrosion resistance (life span is more than 100 years without quality losses), increased durability (3 times more durable than steel), light weight (4 times lighter than steel reinforcement, that provides transportation savings and allows construction of higher structures). Besides this the products of «Galen» are able to withstand high temperatures (long impact up to 700°C and short impact – up to 1000°C) and possess low thermal conductivity (100 times less than metal) which increases the building wall thermal efficiency up to 35%.

You can find detailed information about project company of «Galen» at the website www.galen.su.

14. What large projects is RUSNANO implementing in construction now?

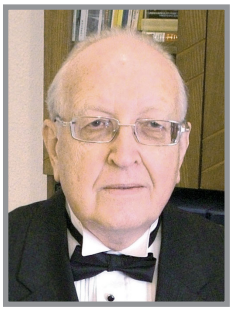
V. Adamova, lecturer

Dear Mrs. Adamova!

The range of RUSNANO's projects aimed at application of nanotechnological approaches in construction is very broad. The largest ones are the project on production of high-performance energy-saving, sun protection and self-cleaning glass held jointly with Group of companies NSG (Pilkington) and Group of companies «STiS» as well as the project on production of thin-film photo converter modules based on Oerlikon Solar 's technological line, the commissioning of which is expected at the end of 2013.

One should also note the projects on production of basalt fibers and materials based on such fibers, production of pavement modifiers, heat-insulating materials made of foamed glass, prepregs used in concrete structure reinforcement, flame-retardant polymers for cabel and façade structures, styrene-acryl dispersions, the use of which results in increase of hardness, gloss value, adhesion and resistance to exposure as well as the projects devoted to water treatment, production of air filtration and disinfection systems and light-emitting lamps.

More information about activities of RUSNANO portfolio companies is available at www.rusnano.com.



FIGOVSKY Oleg L'vovich,
full member of European academy of Science, forein member of REA and RAABS, Editor-in-Chief of SITA, OCJ и RPCS, Director of «Nanotech Industries, Inc.», USA, and Director of International nanotechnological R&D Center «Polymate» (Israel)

2. We are interested in nanomodified, high strength, lightweight constructional concrete possessing low average density and high ultimate compression strength. Earlier it was reported that to produce this type of concrete hollow glass and aluminum silicate microspheres are used. And to increase the adhesion strength of cement stone with the filler, it was suggested to use a complex nanosize modifier based on sol iron hydroxide and sol silicic acid etc.

Tell us about the application of the above technology for concrete production. What objects have been already done? Are there codes for the given type of concrete? Are there economic calculations showing the efficiency of the implementation of the above given concrete etc?

What are the conditions under which the developers are ready to share it with construction companies?

Our company is very interested in new developments in this area and we are ready to consider different options.

S. Cherkov, commercial director of construction company.

The new type of lightweight unreinforced concrete has been developed – USA patent № 8409345.

You need to address a request to the company Malaxit (office in Germany): e-mail NewTechnology@gmx.de

3. Is there a training course for those specialists who will be employed in production of materials and articles with the use of nanotechnologies?

Where and how is this course led?

S. Bonov, technologist (Ukrain)

The first course of innovative engineering and nanotechnologies was delivered by academician professor Oleg Figovsky and assistant profes-

sor Klimentiy Levkov (both are from Israel) within the frames of Skolkovo Open University in Tomsk in autumn 2012. The similar lectures were delivered by Prof. Figovsky and Dr. Blank at universities of Astana and Almaty in 2012–2013.

10. Tell us about the main areas in which nanotechnologies are applied in construction materials production in Russia and abroad? (in the USA, Israel, Great Britain, Germany, Japan, China and others)

A.Rodova, post-graduate (Belarus)

Our review was published in Internet-Journal «Nanotechnologies in Construction» [1]. Many current reviews by Prof.Figovsky are being published at the site: http://park.futurerussia.ru/extranet/blogs/figovsk/.

At the moment the book «Advanced Polymer Concretes and Compounds» by Prof. Figovsky and Dmitry Beilin is being released in the publishing house Taylor & Francis Group, New York.

23. What is the main obstacle to overall introduction of nanotechnologies and nanomaterials in construction in Russia and in foreign countries? (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)?

V. Boldin, post-graduate student

There are no obstacles for wide implementation of nanotechnologies and nanomaterials in USA and Israel. For example, the experience of American company Nanotech Industries, Inc proves that.

The latest direction – the application of 3D printing in building construction.

FALIKMAN Vyacheslav Ruvimovich,
RILEM National Delegate in Russian Federation,
Member of RILEM Bureau, First Deputy Chair of TC 465 «Construction» of Rosstandart, Professor of MSUCE

1. In May, 2012, the IV International Symposium on Nanotechnologies in Construction (NICOM4) was held in Greece. As far as it is known, Internet-journal «Nanotechnologies in Construction» is the official information partner of NICOM4. Are there any plans to publish the participants' reports delivered at symposium in the edition?

A. Rolin, lecturer

Yes, we plan to do that. The editors are negotiating the terms of publication of selected papers with the organizers.

4. The Russian Engineering Academy and consulting company Booz & Co. (just use BOLD) have conducted technological research entitled «Development of construction nanotechnological products market in Russia through 2020». What are the main results of this research? Are there any plans to continue this investigation in this area?

V. Karpov,
Doctor of Engineering

There were several key targets in this project:

- to determine prospective nanotechnological construction materials in the most dramatically developing industrial areas;
- to determine top-priority steps aimed at formation of favourable environment in the industry in order to produce and use nanotechnological products;
- to create subsidiary tool for systematic search of prospective projects in the field of production of nanotechnological building materials and nanotechnological solutions in construction;
- to create subsidiary tool for state regulating bodies in order to main-

tain records when motivation policy for development of construction sector and other industrial areas is being elaborated.

Moreover, according to results of the investigation design and construction companies will get a good base for reasoned choice of the most efficient building nanoproducts which meet present-day requirements on energy efficiency, safety, ecological compatibility, durability, economic effectiveness.

RUSNANO, construction companies, producers of building materials, design offices, state regulating bodies, investors, and research institutes are assumed to be the end-users of technological research.

The implemented work employed leading experts, specialists of research, design and technological organizations, manufacturers that produce and supply nanotechnological products, universities, which train engineers, special public unions and associations. Within the frames of the project existing similar analytical investigations in different countries have been generally analyzed; common trends of construction market in the field of building materials and application of these materials have been determined; main “players” at the world market and main nanotechnological centers in construction industry have been identified; the most important area for new developments have been studied.

According to fulfilled analysis, executors have reasonably chosen key segments of construction materials produced with the use of nanotechnologies and have defined more exactly the present state of selected segments in the world construction industry with description of the most successfully applied technologies. The particular attention in the report was focused on the estimation of the principle problems, arising when the nanoproducts are promoted from the design stage to the stage of consumption by end-users; existing codes, regulating application of innovative building materials. Some examples of positive and negative influence of state normative regulation in the area of production and application of innovative construction products are shown.

Technological research has determined the main players at the international market of innovative materials and technologies and the most important field for the new developments (main research groups, manufacturers, innovative construction companies).

The most important part of the project is analysis and forecast of the possible development of Russian Federation’s market for the selected seg-

ments in qualitative and quantitative indicators, new materials and technologies which are prospective for implementation in RF with the description of the application areas (forecast time horizon – 2015, 2020 and 2025). At the same time SWOT-analysis of efficiency of innovative materials application has been done in selected segments by technical and economic indicators (in respect to the traditional materials).

It was extremely important, from the implementators' point of view, to reveal existing in Russia economic, legislative and other obstacles which hamper promotion of innovative materials at the market as well as to find the drivers and motivation factors of the innovative material market. Lastly the work resulted in «Road maps» on application of nanomaterials and nanotechnologies in construction covering 6 segments (cement and concrete; wood and woodworking; composites; paints and coatings; glass; thermo-insulation) and building materials, on the whole; action plan to strengthen «road maps»; recommendation on 14 prospective projects, as well as general approaches to overcome barriers and create favourable environment for development of nanomaterials and nanotechnologies in construction.

All that, as we consider, allows us to determine short-term, medium-term and long-term prospects, as well as to design concrete ways for wide utilization of the latest achievements to increase quality of construction; to provide durability and reliability of buildings and structures; to protect environment and decrease total costs.

Further development of the works is directly depends on the RUSNANO's and the state's plans concerning reequipment and integration of the lagging construction industry into international market of high technologies, provision of competitiveness of domestic high-end products, that would allow Russia to restore and maintain the parity with the leading states in resource- and energy-saving, to create ecologically adapted manufacturings, to improve the quality and level of national living standards as well as to sustain proper level of state's security.

8. The V International Symposium on Nanotechnologies in Construction (NICOM 5) is known to be held in 2015 in Chicago, USA. Is there a list of questions and areas to be discussed at the symposium?

K. Kolev, Ph.D. in Engineering

The main problems to be discussed at the nearest symposium on nanotechnologies in construction are quite common for such forums. These are the most important:

- Production, functionalizing and characteristics of nanomaterials: nanoparticles, nanotubes and new polymers;
- Investigation of inner structure and properties of construction materials at the nanolevel and dependence of these parameters on their behaviour at macrolevel;
- Tools, methods and metrology to study construction materials at nanolevel;
- Nanomodification of construction materials, including functional films and coatings;
- Nanotechnologies for high strength and high functional materials;
- Nanomaterials for significant increase of durability;
- Self-repairing, «smart» nanostructured materials;
- Photocatalysis and air- and self-cleaning materials;
- Biomimetic nanocomposite materials;
- Nanoassembling and «from bottom to top» technologies in construction materials;
- Modeling and reproduction of construction materials nanostructures;
- Nanotechnologies and nanomaterials for energy efficient construction;
- Nanotechnologies contributing to obtaining of «green materials» and usage of by-products for the new level of sustainable development;
- Application of nanomaterials in real construction projects;
- Nanotechnologies and nanomaterials for transport infrastructure development;
- Protection of health, labour and environment related to the application of nanomaterials.

You can find information about symposium at website NICOM5.org.

9. The Internet Journal «Nanotechnologies in Construction» published industrial technological research entitled «Development of construction nanotechnological products market in Russia through 2020» (№1, 2013). It announced that the authors are inviting all interested specialists and special organizations to take part in wide public discussion of the research results. In what way will this discussion be held?

K. Kolev, Ph.D. in Engineering

This discussion was held and is held in different forms. First of all, several Round tables have already took a place. These Round tables gathered a lot of participants from scientific institutes and universities, designers, specialists working in construction industry and building enterprises, foreign specialists. The discussion resulted in certain corrections and additions to report. Secondly, results of the research are widely published in the main industrial journals – Internet-journal «Nanotechnologies in Construction», «Industrial and Civil Engineering», «Construction Materials» and in other mass media. Authors will be grateful for any offers concerning the published papers, using the contacts provided by editors. Finally the results of industrial technological research were reported at some international conferences including IV International Symposium on Nanotechnologies in Construction (NICOM4) in Greece and were highly appreciated by the participants.

11. Mass media reported on the creation of a new production of a composite nanostructured polymer reinforced with basalt fibers in Cheboksary. This material is not affected by corrosion. It is as strong as steel but it has a higher resistance to wear. What is your opinion on that?

S. Baranov, the head of construction company

Nowdays to reinforce bearing and walling structures one uses non-metallic composite reinforcement of different types (glass-fiber; basalt fiber reinforced plastic; basalt fiber reinforced plastic with the use of carbon fiber, carbon-fiber-reinforced plastic and hybrid) with nominal diameter of the rod 4–32 mm.

This reinforcement may have various die-rolled sections ensuring the required bond strength between a bar and concrete including conditions under prolonged exposure to corrosive environment according to GOST 31384-2008. Production lines on nonmetallic composite reinforcement have been installed in many Russian cities (Biysk, Ekaterinburg, Cheboksary, Izhevsk, Omsk, Chelyabinsk, Yakutsk etc.). The compound annual growth rate (CAGR) of these lines is more 15%. and production capacity is more 30 000 km of rods per year. Only in Moscow region there are more than 27 plants that produce composite reinforcement. Different countries all over the world show interest in Russian nonmetallic composite reinforcement. The Association of Non-Metallic Composite Reinforcement Manufactur-

ers and Users was registered in May, 2012, in Russia, thereby allowing to unite the interests of science, design organizations, manufacturers and users of non-metallic composite reinforcement and to ensure the new level of its application.

At present the inter-state standard GOST 31938-2011 «Polymer composite reinforcement for concrete structures. General specifications» has been developed and approved by eight CIS countries. Within the framework of medium-term programs of standardization under RUSNANO sponsorship a group of standards is developed referring to test methods of non-metallic composite reinforcement with the purpose to determine its physical and mechanical characteristics, resistance properties in corrosive environment, structural and thermomechanical characteristics, as well as the Code of practice on the analysis and design of elements with non-metallic composite reinforcement is being developed.

19. In what way can the designers use the most efficient construction nanotechnology in their projects? How is that done in foreign countries (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)?

K. Sotov, the head of design company

It is obvious that existing legislation keep under implementation of nanotechnological products. That is due both reasons. The first one is an extremely inert admittance system for innovative products in the market by approval using technical certificate issued by Federal Center on Standardization and Technical Evaluation in Construction. This legal body has given only about 500 certificates for the last 10 years (due to insufficient resources and unwilling risks). The second reason is notorious Federal law 94-FZ. As the main contractor for large construction objects are state authorities, they must obey the public purchasing law when estimation of the project is done only by its cost. In fact, that keeps under implementation of innovation products.

The same problems can be seen in the field of maintenance of buildings and structures. The present reality is that the builder's responsibility finishes at the moment when the objects is put into operation, therefore he is not motivated to consider the total cost of ownership of the building when designing and executing the works. The design of the objects is done with-

out life-cycle cost analysis, e.g. without well-known in foreign experience «life-cycle contract».

The commercial potential is directly depends on the supporting legislative base as well as the more efficient processes of state regulating of the industry. There are some laws which have already been passed or can be passed in the near future and which could provide more favourable regulating environment. First of all, these are Federal Law of Russian Federation of 28 November 2011 337-FZ «On the Making Changes in City Planning Code of Russian Federation and Individual Acts of Law of Russian Federation» concerning non-governmental examination, Law on obligatory insurance of construction risks, change 94-FZ.

Thus introduction of obligatory insurance of construction risks will cause additional motivation for establishment of supplementary state body which is interested in increase of construction work quality and provision of longer building life span, builder's long-term financial interests when performing project, partial withdrawal of responsibility from regulating bodies. As for 94-FZ, despite the fact that this law is not considered to be changed now, there is a probability of reversal of law due to the elaboration of legislation of Custom union and Eurasian Union.

The point to be emphasized is that Russia is significantly behind the developed countries by staff qualification at all stages of cost creation chain. Some obstacles related to low qualification of industrial staff influence on Russian potentialities in a negative way. These obstacles are: the lack of design offices' experience in the area of application of construction materials with nanocomponents, poor contractors' awareness on the new technologies for construction employing nanocomponents, low technological level of manufacturing building materials which are common for Russia, insufficient efficiency of scientific community's activities.

21. According to experts one of the least investigated problems concerning the use of nanomaterials and nanotechnologies in construction is the safety of these materials to the people. When constructing modern buildings and facilities, one takes into account how long its service life will span but it is not clear how nanomaterials will perform «behave» in 30, 50 or more years. What do you think about that? What are the opinions of the specialists from the USA and Europe?

L. Barko (Republic of Kazakhstan)

It's fair to say that one shouldn't forget about certain risks of application of nanotechnologies – true and sham ones. On the one hand, the state as designated bodies and organizations should support additional investigations for better understanding of all existing risks of innovative materials application, on the other hand – these regulators should contact to non-governmental institutes and public to explain the proved facts and to eliminate prejudices.

For example, Australian health and safety regulating body takes its active stand for EHS risk studies. It reviews existing state's legislation and contributes to re-examination of it abroad, support research and creation of the base of the knowledge on nanotechnological risks. The main focus of the work – to create normative and legislative base, to support research in order to find out harmful properties of nanomaterials, to evaluate the efficiency of control over risks of nanomaterials application at work place, to provide Australian organizations with information on nanotechnologies, to participate in international initiatives and to bring in correspondence with international approaches.

For the last several years one could witness positive trend in research devoted to EHS in nanotechnological building materials. In particular EU and the USA collected large amount of data on the EHS risks that allows them to design the strategy of future work.

22. What nanotechnological construction materials are considered to have the greatest potential in Russia and in foreign countries (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)?

V. Boldin, post-graduate student

Detailed analysis and long-term forecast of development of research and application of nanomaterials and nanotechnologies in building materials manufacturing shows that several segments of market activity can be clearly marked today (table 1). First five segments consume more than 90% of the total amount of nanotechnological products in building materials, at that the share of cement and concrete is more than 40% of all nanotechnological products in building materials (the scope of the market – 5,6 b. doll) and the forecast annual growth is more 10% in 2012–2015.

More detailed information is available on the pages of Internet-Journal «Nanotechnologies in Construction», in which the results of industrial technological research «Development of Russian Market of Nanotechnological Products in Construction Until 2020» have been published [2].

Table 1

The most attractive segments of nanotechnological construction material market

Segment	Scope of the market, b. doll.	Forecast growth in 2012–2015
Paints and coats	6	50%
Cement and concrete	5,6	10%
Glass	0,7	15%
Bitumen and polymers	0,5	10%
Isolation	0,3	50%
Wood	0,3	12%
Ceramics	0,2	15%
Steel, reinforcement	0,2	10%
«Smart» materials	0,05	40%

23. What is the main obstacle to overall introduction of nanotechnologies and nanomaterials in construction in Russia and in foreign countries? (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)?

V. Boldin, post-graduate student

There are some objective barriers that keeps under commercial activities related to nanotechnological products in global scale, both for producers (suppliers) and consumers (fig. 1, 2).

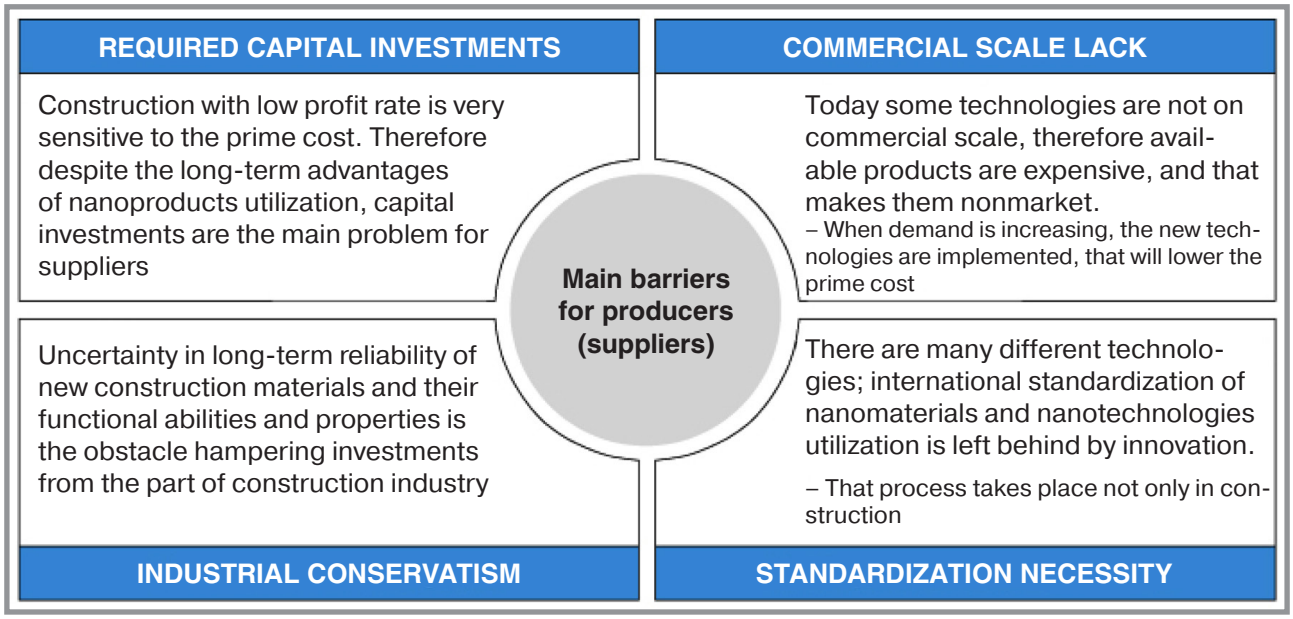


Fig. 1. **Main barriers for producers (suppliers) of nanotechnological products**

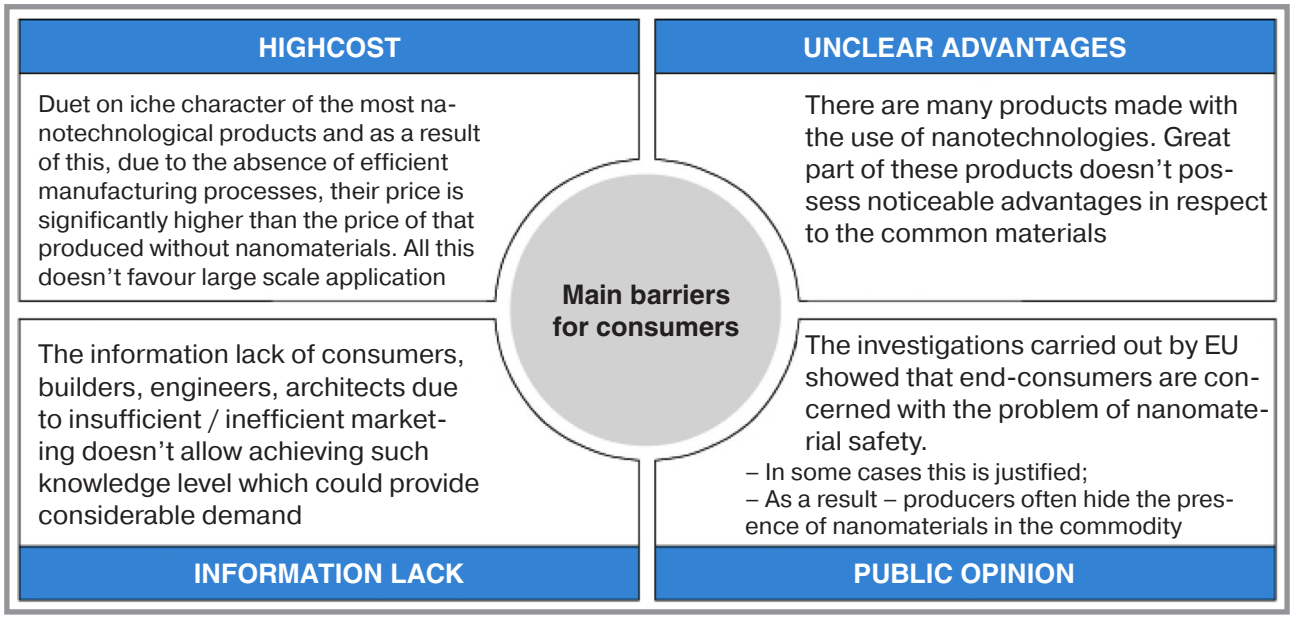


Fig. 2. **Main barriers for consumers of nanotechnological products**

BELOV Vladimir Vladimirovich,
Vice-rector on innovation and scientific-educational activity of Tver State Technical University, Chair of the Department «Processing of building materials and structures», Honourable Worker of Science and Education of the Tver Region, Doctor of Engineering, Professor, Adviser of Russian Academy of Architecture and Construction Sciences

2. We are interested in nanomodified, high strength, lightweight constructional concrete possessing low average density and high ultimate compression strength. Earlier it was reported that to produce this type of concrete hollow glass and aluminum silicate microspheres are used. And to increase the adhesion strength of cement stone with the filler, it was suggested to use a complex nanosize modifier based on sol iron hydroxide and sol silicic acid etc.

Tell us about the application of the above technology for concrete production. What objects have been already done? Are there codes for the given type of concrete? Are there economic calculations showing the efficiency of the implementation of the above given concrete etc?

What are the conditions under which the developers are ready to share it with construction companies?

Our company is very interested in new developments in this area and we are ready to consider different options.

S. Cherkov, commercial director of construction company

According to our approach which has been already partly implemented in our inventions [3,4] we consider that prospective source for lightweight concrete nanoadditives can be clay minerals or smectites which are the main components in widely spread bentonite. These components possess almost all properties of natural nanosize particles and generally they are used unsystematically in production of construction materials [5]. The manufacture of nanoparticles from bentonite – a complex process based on the use of thin technologies demanding fundamental research and especially knowledge in the area of bentonite mineralogy. At the same time bentonite clay is a peculiar half-finished material and it is the basis for industrial production of nanoparticles. When producing nanopowders from bentonite

clay it is advisable to perform nanostructural preparation in special mechanical activators, for example, planetary vibrating mill.

The papers [6, 7] dealt with the influence of waste dust and clay particles on the properties of aerated concrete. Due to high dispersiveness such particles tend to aggregate into small flocculs. To destroy micrograins of these particles authors offer to use mechanochemical activation of combustible mixture on the special grinding facility. Such facility allows discovering reactive ability of these particles due to formation of intermediate amorphous states on their surface, in particular silicon dioxide and alumina. The research in which the DTA, XRF methods and electronic microscopy were used proved that chemical interaction takes place between clay minerals and hydrated neoplasms of compound binder. As a result under the condition of reduced CaO concentration in liquid phase along with high-basic calcium silicate hydrate and calcium hydro aluminates low-basic ones are formed too, mainly in the fine dispersed form or needles and fibers. The hydrosilicate isolation contributes to structure densification and increase the hardness of solidified stone. It was determined that total capillary porosity of activated mixtures matrix decreased three times as much compared with nonactivated ones, and maximum of capillary pores distribution shifts to the side of smaller pores due to disaggregation of dangerous capillary pores, that increases durability of membranes between pores in non-autoclaved porous concretes. Non-autoclaved aerated concretes with the average density more than 400 kg/m which strength characteristics similar to the ones of autoclaved aerated concrete were obtained from combustible mixtures containing waste dust.

The paper [8] investigated the influence of nanoparticles on the characteristics of foam concretes of non-autoclaved hardening. It was determined that compressive strength of the foam concrete which average density is 500 kg/m and modified with nanoparticles was 1,65 MPa, and for non-modified 0,87 MPa (strength growth is 1,9 times). The maximal strength was reached when content of nanostructures was 0,05%. The increase of nanostructures content causes the strength decrease. The samples with modified structure compared with those with non-modified structure possess even distribution of pores by size, the surface of the samples is smooth (without splits). Nanoparticles when distributing in the concrete structure, functionate like direct crystallization centers. On the one hand, that leads to the appearance of fibrillary structure, on the other – to the appearance of hardening

structure-oriented submolecular covering round the nanotube. This process provides increased strength of porous concrete and pores uniformity by size.

The paper [9] determined that the presence of carbon nantubes in foam concrete provides stabilization of its structure, absence of perforation holes in the tube walls, which often appear in the ordinary foam concrete. The presence of pores with perforation hole walls in non-modified foam concrete results in decreased strength and worse mechanical properties of the investigated material.

The paper [10] considers the use of modifying additives in the form of carbon plate nanosystems in production of porous synthetic anhydrite composition. The authors marked stabilization of aerated synthetic anhydrite structure by size and pores shapes. The results of microstructure research showed that in porous synthetic anhydrite composition without modifying nanosystems due to intensive pore walls percolation pores aggregate into large pores which additionally rise thermal conductivity of porous composition and decrease its mechanical characteristics.

Common answer to the questions:

10. Tell us about the main areas in which nanotechnologies are applied in construction materials production in Russia and abroad? (in the USA, Israel, Great Britain, Germany, Japan, China and others)

A. Rodova, post-graduate (Belarus)

12. Are there any nanomaterials where small amounts of additives improve the characteristics of the construction composites?

V. Kovrov, engineer (Kazakhstan Republic)

19. In what way can the designers use the most efficient construction nanotechnology in their projects? How is that done in foreign countries (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)?

K. Sotov, the head of design company

Some methods of nanotechnologies are widely used in production of ultra high performance concretes. When using high-performance chemical additives, active and inert fine dispersed and nanodispersed mineral com-

ponents, homogeneous concrete matrices are formed. These matrices being treated and compacted properly don't contain voids. The main aspect in all cases is that diameter of the filler grain is decreased compared with traditional type of concrete. As the research results proved the linear dependence between decreased grain diameter and compressive strength limit, the maximum size of the filler grain in ultra high performance concrete is 1 mm. Today nanofillers including nanofibers are also used, they play revolutionary role in increasing strength and improving other characteristics of these composites.

Modern developments in production of ultra high performance concrete are based on the general postulate, saying that defects, pores and microcracks will come to naught and the concrete structure will be homogenated if the initial componets are chosen properly and the optimal receipt of the mixture is determined. Mainly special receipts of ultra high performance concrete are associated with the very high bending and tensile strength characteristics. These ideas are elaborated by the following requirements:

- improvement of homogenizing by the means of elimination of coarse-grained components;
- improvement of compactness through optimization of grain-size composition of mineral components mixture;
- improvement of microstructure through thermal processing at the last stage of concrete hardening;
- use of the modern mixing and concreting technologies in production of ultra high performance concrete;
- use of the fibers and fibers combinations to decrease brittleness and to increase strength of the concrete.

Strength characteristics of ultra high performance concrete make it possible to reduce cross-section mainly of prestressed building structures. That causes considerable reduction of structures' own weight which is important in erection of vertical building structures, tall buildings, especially in prefabricated construction, in bridge engineering. Another aspect refers to the «risky» foundations, which in extreme situations take away significant amount of the financing intended for whole construction. It is obvious that consistent reduction of vertical structure's own weight leads to profitability increase.

SOBOLEV Konstantin Gennadievich,
Associate Professor of University of Wisconsin-Milwaukee, USA, Chairman of Technical Committee ACI 236D on nanotechnologies in concrete of American Concrete Institute

1. In May, 2012, the IV International Symposium on Nanotechnologies in Construction (NICOM4) was held in Greece. As far as it is known, Internet-journal «Nanotechnologies in Construction» is the official information partner of NICOM4. Are there any plans to publish the participants' reports delivered at symposium in the edition?

A. Rolin, lecturer

Interesting question! All NICOM4 papers were published on a CD and only selected 20 papers were published in Cement and Concrete Composites Special issue: Nanotechnology in Construction: http://www.sciencedirect.com/science/journal/09589465/36.

I believe that the remaining papers may be published by the Internet-journal «Nanotechnologies in Construction», but this is up to the authors. BTW, there is a call for abstracts for NICOM5, so it is a perfect time to submit an abstract! Please see more information at NICOM5.org

2. We are interested in nanomodified, high strength, lightweight constructional concrete possessing low average density and high ultimate compression strength. Earlier it was reported that to produce this type of concrete hollow glass and aluminum silicate microspheres are used. And to increase the adhesion strength of cement stone with the filler, it was suggested to use a complex nanosize modifier based on sol iron hydroxide and sol silicic acid etc.

Tell us about the application of the above technology for concrete production. What objects have been already done? Are there codes for the given type of concrete? Are there economic calculations showing the efficiency of the implementation of the above given concrete etc?

What are the conditions under which the developers are ready to share it with construction companies?

Our company is very interested in new developments in this area and we are ready to consider different options.

S. Cherkov, commercial director of construction company

Excellent question. There are two connected teams in the USA (FHWA and UW-Madison) which develop SiO_2 and Al_2O_3 nano-coatings for aggregates (mainly normal-weight) to improve the bond. This development can be extended to lightweight aggregate concrete. I will be happy to connect you with the research team so you will be able to discuss the details of implementation.

3. Is there a training course for those specialists who will be employed in production of materials and articles with the use of nanotechnologies? Where and how is this course led?

S. Bonov, technologist (Ukrain)

In the USA the preparation of specialists in the field of construction nanotechnologies is mainly at graduate (MS and PhD) levels. Existing BS programs are very busy with core civil engineering (and material science in case of materials program) classes. Actually, better engineering preparation programs might be very close geographically. For example excellent program on construction material science and nanotechnology is established in Belgorod (Belgorod State Technological University named after V.G. Shoukhov).

6. What higher educational institutions are training (planning to train) specialists in the area of nanotechnologies in construction? When will the first graduates be? Will they be engaged in the scientific activities?

V. Karpov, Doctor of Engineering

For example excellent program on construction material science and nanotechnology is established in Belgorod (Belgorod State Technological University named after V.G. Shoukhov).

8. The V International Symposium on Nanotechnologies in Construction (NICOM 5) is known to be held in 2015 in Chicago, USA. Is there a list of questions and areas to be discussed at the symposium?

K. Kolev, Ph.D. in Engineering

Wide range of aspects related to ALL construction materials; for detailed information on NICOM5, please check NICOM5.org. We expect many participants from Russia, please submit the abstract before the deadline.

10. Tell us about the main areas in which nanotechnologies are applied in construction materials production in Russia and abroad? (in the USA, Israel, Great Britain, Germany, Japan, China and others).

A. Rodova, post-graduate (Belarus)

There are many nanoproducts available in the market: superplasticizers, nano-SiO_2 (mainly for self-consolidating concrete), nano-TiO_2 and photocatalytic cements, etc. At ACI 236D (Nanotechnology of Concrete) we are about to finalize the report on application of nanotechnology in concrete. At the moment draft is available for members only, but we hope that it will be published soon! Please see other document with excellent review from TRB of the National Academies (USA): http://onlinepubs.trb.org/onlinepubs/circulars/ec170.pdf.

12. Are there any nanomaterials where small amounts of additives improve the characteristics of the construction composites?

V. Kovrov, engineer (Kazakhstan Republic)

We developed nano-SiO_2 additive which at very small dosage 0,25% of cement weight can improve 1- and 28-day strength by 25%. We believe nanoparticles must be used (and be effective) in very small dosages. Otherwise, these are not attractive for practical application.

15. What can you tell us about the application of nanomaterials and nanotechnologies in construction abroad? (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)

E. Korotkih, construction engineer

See my answer for № 10.

17. How are the specialists in the area of nanotechnologies in construction abroad trained (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)?

B. Zotova, lecturer

See my answer for № 3.

21. According to experts one of the least investigated problems concerning the use of nanomaterials and nanotechnologies in construction is the safety of these materials to the people. When constructing modern buildings and facilities, one takes into account how long its service life will span but it is not clear how nanomaterials will perform «behave» in 30, 50 or more years. What do you think about that? What are the opinions of the specialists from the USA and Europe?

L. Barko (Republic of Kazakhstan)

I believe we are not using nanomaterials alone; these are incorporated into composites enhancing their performance. With superhydrophobic admixtures we developed at UW-Milwaukee (super-beton.com) we expect the enhancement of service life of common concrete by factor 5. Regarding safety: yes, nanomaterials are highly dispersed and very reactive materials which must be handled with care. For application in concrete we advise using water based products since these can be handled as common chemical admixtures.

KOROLEV Evgenij Valerjevich,
Director of the Research and Educational Center «Nanotechnology», Moscow State University of Civil Engineering, Doctor of Engineering, Professor

2. We are interested in nanomodified, high strength, lightweight constructional concrete possessing low average density and high ultimate compression strength. Earlier it was reported that to produce this type of concrete hollow glass and aluminum silicate microspheres are used. And to increase the adhesion strength of cement stone with the filler, it was suggested to use a complex nanosize modifier based on sol iron hydroxide and sol silicic acid etc.

Tell us about the application of the above technology for concrete production. What objects have been already done? Are there codes for the given type of concrete? Are there economic calculations showing the efficiency of the implementation of the above given concrete etc?

What are the conditions under which the developers are ready to share it with construction companies?

Our company is very interested in new developments in this area and we are ready to consider different options.

S. Cherkov, commercial director of construction company

Energy efficient nanomodified high strength lightweight concrete with inclusion of nanomodified glass and aluminum silicate hollow spheres developed in Research and Educational Center «Nanotechnology» (Moscow State University of Civil Engineering) possesses low average density and high strength. These two properties determine material's technical characteristic called – strength-to-weight ratio, calculated as a ratio between ultimate compressive strength and relative density of the material (unit – MPa). Many researchers are developing technology of high strength lightweight concrete all over the world. The strength of the obtained compositions is more 50 MPa and the average density is more 1800 kg/m^3. At that strength-to-weight ratio varies within the range 7,5...30 MPa. The strength-to-weight ratio of the high strength lightweight concrete devel-

oped at MSUCE is 35...55 MPa (average strength – 1300...1500 kg/m^3; ultimate compressive strength – 40...65 MPa; thermal-conductivity coefficient don't exceed 0,6 W/m • K).

The implementation of new construction technologies is practically always followed by redistribution of the material costs, work costs and operational cost. The approximate cost of 1 m^3 of nanomodified concrete is about twice more expensive than that of the traditional concrete. At the same time the experimental results we obtained prove that average density of the concrete being produced according to the new technology decreases by 35...48%.

That makes it possible to increase the number of storeys in the building or reduce material capacity (the increase of the storey number and total actual living space in building can be up to 44%). Thermal conductivity of the new concrete is by 45% less than that of the traditional one. During winter that leads to the heat losses reduction, at the same time providing additional decrease of operational costs in long-term period.

The products made of new concrete improve ergonomic characteristics of structures (as a result of increased acoustic absorption), decrease the loads on the harnesses and bearing elements, reduce transportation and assembling costs as well as foundation costs. Reinforcement steel expenditures are cut down (up to 30%) and structures cross-section becomes smaller.

Practical implementation of high strength lightweight concrete technology was carried out at the enterprise belonged to the group of companies «SU-155». The experiments showed that it is difficult to obtain specified concrete characteristics using traditional equipment of the most construction plants. Developed technology is being efficiently realized on the up-to-date manufacturing equipment but, unfortunately, on the foreign one.

10. Tell us about the main areas in which nanotechnologies are applied in construction materials production in Russia and abroad? (in the USA, Israel, Great Britain, Germany, Japan, China and others)

A. Rodova, post-graduate (Belarus)

In foreign countries nanotechnologies are used to develop a wide range of construction materials with unique characteristics. These are:

- Materials of decreased density and increased strength for bridges, tall buildings and large-span structures;

- Materials with increased resistance to the impacts of aggressive environments and atmospheric factors;
- Adhesives and materials for manifold coating;
- Materials with increased thermal resistance;
- Heat- and fire-resistant materials;
- Materials with increased sound absorption;
- Materials for light-reflecting coatings or coatings with increased transparency;
- Additives for construction composites of different purpose.

Development of nanotechnological methods in construction material science made it possible to improve primary products of construction industry – cement concretes. For example, usage of nanodimentional silica admixture is said to increase considerably ultimate compressive strength of the concrete which composition comprises large amount of flue ash. The structure of the porous space is improved – pores between relatively big particles of flue ash are filled with nanodimentional hydration products. Suspension of amorphous nanosilica is used to prevent delamination of self-packing concrete mixes.

Application of nanomodifiers based on carbon nanomaterials – fullerenes, astralenes, carbon nanotubes – creates the conditions for formation of line nanoobjects made of hydration products in the cement concrete structure. Synthesized nanoobjects play the role of dispersed reinforcement increasing physical and mechanical characteristics of the material.

Relatively new area in cement concrete technology is to use dispersed phases with modified surface (so-called carriers). Nanomodification is a consequence of technological procedures aimed at treatment of carrier with colloidal solution and further usage of modified dispersed phase in the common or altered technological chain.

Many modification methods which include usage of polymer materials are referred to cement composites nanotechnology. First of all, this is technology of efficient plasticizers (called superplasticizers and hyperplasticizer) based on polycarboxylates which have been known for a long time. Synthesis of new dendrimer structures – hyperplasticizer molecules – is regarded to be the most rapidly developing field in nanotechnology of construction material science for cement concrete industry.

Polymer materials can be used not only as plasticizers – now the area of cement-polymer composites is being advanced. In particularly Japan has

been developing and studying the properties of such materials for more than 50 years and today they are ones of the top construction materials in this country. Perspective fields for application of cement-polymer composites are the compositions used in repairs and renovation, materials for the structures with increased waterproofing and decreased permeability.

Considerable part of scientific developments concerns nanostructured coatings of specific functionality.

12. Are there any nanomaterials where small amounts of additives improve the characteristics of the construction composites?

V. Kovrov, engineer (Kazakhstan Republic)

For carbon nanoparticles as well as for oxide nanoparticles experimental results show that to increase operational characteristics of cement concrete it is enough to use nanoobjects taken in micro quantity. There is also another reason explaining the micro quantity of nanoobjects additives.

The particular feature of the primary nanotechnological products, especially carbon and oxide nanoobjects, is the high cost. For example, the cost of 1 kg single-walled carbon nanotubes with the cleanness 90% is about 100 thousand dollars; tenfold toughening of the requirements to purity causes the rising degree of cost. Despite the fact that the cost of multiwalled nanotubes is less by one-two degree, it doesn't allow using large amount of such nanoobjects into large-tonnage construction materials.

Concentration of nanoobjects in polyfunctional construction coatings – hydrophobic, biocide and self-cleaning (photocatalytic) is relatively high. But due to thin thickness of the coatings, high cost of the primary nanotechnological products is not the factor which leads to the considerable rise of the cost of the construction product overall.

13. What national projects concerning the development of nanomaterials and nanotechnologies in construction are being implemented abroad? (in the USA, Israel, Great Britain, Germany, Japan, China and other countries) What kind of success are they having?

V. Adamova, lecturer

First of all this is National Nanotechnology Initiative – long-term research and development program which is being implemented in the USA

since 2001 financial year. Within less than 10 years after the program had been launched the activity of almost 100 research centers have been coordinated and almost 25 corporations and ministers have been united, including National Scientific Fund, Ministry of Defense and other government organizations of the USA. It is expected that for the whole period of realization (2000–2020) the project financing will be about one hundred billions. Programs, similar to National Nanotechnology Initiative, have been executed in Japan and South Korea (since 2001), Germany, Taiwan and China (since 2002), Israel (Israel National Nanotechnology Initiative).

Within the frames of the programs stated above the works on creation of nanostructured composite materials which find an application for construction are carried out. As an example of such materials one can regard self-cleaning and selective glasses (AGC Glass Europe). Wide range of nanomaterials for construction was developed by research and manufacturing company Polymate Ltd, branches of which are located in the USA, Europe and Israel. The results of experiments are published in the journal «Scientific Israel – Technological Advantages». These are the developments:

- Hybrid polymer composition materials based on interpenetrating macromolecular networks comprising fragments of hydroxyurethanes;
- Hybrid nanostructured materials based on non-isocyanic polyurethane;
- Different functional additives for polymers;
- Constructional composites with thermoset organosilicate matrix;
- Polymer concrete of special purpose with polybutadiene matrix;
- Functional base coats – adhesives for concrete with damp surface;
- Biodegradable hydrophobic coatings;
- Anticorrosion liquid nanocompositions.

Materials nanostructuring based on non-isocyanic polyurethane allows increasing of hydrolytic stability of cohesions and raises chemical resistance by 50...100% . Anticorrosion liquid nanocompositions with improved technological operational characteristics are resistant to the impact of acids under the temperature up to 100°C et al.

15. What can you tell us about the application of nanomaterials and nanotechnologies in construction abroad? (in the USA, Israel, Great Britain, Germany, Japan, China and other countries)

E. Korotkih, construction engineer

In foreign experience nanotechnological methods of construction material science proved their effectiveness when developing coatings for construction products. If at the first stage of becoming of nanotechnology in construction material science it was photocatalysis (biocide and self-cleaning coatings) which was brought to the main focus, now the number of application areas has dramatically increased.

For instance, AGC Glass Europe commercially produces wide range of functional transparent, selective and photovoltaic building products.

Functional transparent products for civil and industrial application can possess sound-proofing and thermal-insulating properties, increased impact-resistance. Selective products – specific screens which absorption spectrum in the visible range is practically flat (except red – due to this reason, light passing through them becomes blue) but from the near infrared the absorption dramatically increases. Photovoltaic products – «transparent solar batteries» which not only bring down illumination in the room to specified level but also generate electric power at the same time.

In 2010 AGC Glass Europe set glass production line in operation in Russia.

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