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Nanotechnologies in Construction: A Scientific Internet-Journal

Nanotehnologii v stroitel'stve: nauchnyj Internet-zhurnal

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УДК 69

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DEVELOPMENT OF NANOTECHNOLOGIES – THE MOST IMPORTANT TECHNOLOGICAL DIRECTION IN CONSTRUCTION
(Internet-Journal «Nanotechnologies in Construction» is two years!)

Today nanotechnologies and nanoindustry are the most prospective directions for the development of science, technologies and industry. Many countries including Russia develop new types of nanoindustry products which have already appeared or are to appear at the market within the next few years. Mass media plays the key role in information support of creation and implementation of nanotechnological production. Therefore on Russian Engineering Academy's initiative Internet-Journal «Nanotechnologies in Construction» was founded in 2009. Despite of unstable situation in the country and the world the edition is gradually developing and growing. As the Chair of Central branch of RAACS, academician Chernyshov E.M. said: «... it is difficult to underestimate the significance of the journal for scientists and construction engineers. The idea of creating a journal was found to be very favorable, the appearance of specialized edition considerably enabled the scientists' works in construction nanotechnologies».

Key-words: Internet-Journal «Nanotechnologies in Construction», nanotechnological production, nanoindustry.

Участники II Съезда инженеров России и Всероссийской научно-технической конференции по инновационным технологиям (25–26 ноября 2010 года, г. Москва) отметили, что для страны актуальными технологическими направлениями в строительной отрасли являются: развитие нанотехнологий, инновационных строительных технологий, нацеленных на создание комфортных и экологичных строительных материалов и архитектурных форм нового поколения, получение качественно новых материалов, включая развитие современного материаловедения [1].

Действительно, нанотехнологии и наноиндустрия являются в настоящее время одним из наиболее перспективных направлений развития науки, технологий и промышленности. Во многих странах, в т. ч. и в России, разрабатываются новые виды продукции,

Participants of the II Congress of Engineers of Russia and All-Russian Scientific and Technical Conference on Innovative Technologies (25–26 November 2010, Moscow) marked that development of nanotechnologies and innovative construction technologies aimed at creating new generation of comfortable and ecologically friendly building materials and architectural forms, as well as obtaining qualitatively new materials including development of modern materials science [1] are important technological fields in construction for the country.

In fact today nanotechnologies and nanoindustry are the most prospective directions for the development of science, technologies and industry. Many countries including Russia develop new types of nanoindustry products which have already appeared or are to ap-

которые уже появились или появятся на рынке через несколько лет.

Наличие издания, в котором публиковалась бы аналитическая информация о нанотехнологиях в строительстве, имеет очень важное значение для развития отрасли и наноиндустрии в целом. За два года коллективу редакции, редакционному совету и редакционной коллегии Интернет-журнала «Нанотехнологии в строительстве» удалось достичь очень многого. Кратко остановимся на основных моментах развития журнала.

Электронное издание «Нанотехнологии в строительстве: научный Интернет-журнал» зарегистрировано как самостоятельное средство массовой информации в Министерстве связи и массовых коммуникаций Российской Федерации (свидетельство о регистрации Эл № ФС77 – 35813 Федеральной службы по надзору в сфере связи и массовых коммуникаций).

Основной целью электронного издания является информационное обеспечение процесса создания и внедрения наукоемких технологий (прежде всего – нанотехнологической продукции) в области строительства [2].

Создание и использование электронных научных изданий приобрело особое значение как средство научной коммуникации в образовательной и научной среде. Возможность публикации результатов научных исследований в электронных изданиях, в особенности размещенных в Интернете, их сохранности представляют значительный интерес для соискателей ученых степеней и научного сообщества в целом.

Электронное издание «Нанотехнологии в строительстве: научный Интернет-журнал» включено в Перечень ведущих рецензируемых научных жур-

pear at the market within the next few years.

The presence of the edition that could publish analytical information about nanotechnologies in construction is of great importance for industry development and nanoindustry in a whole. Within two years the staff of the journal, editorial board and editorial council of the Internet-Journal «Nanotechnologies in Construction» have achieved a lot. This is a shortlist of the milestones of the journal life.

The electronic edition «Nanotechnologies in Construction: A Scientific Internet-Journal» is registered as an independent mass media in the Ministry of Communication and Mass Media of The Russian Federation. (Registration Certificate Эл № ФС77 – 35813 by the Federal Service on Supervision in the Sphere of Connection and Mass Communications).

The main aim of the electronic edition is to provide information support for the creation and implementation of science intensive technologies (especially nanotechnological products) in the construction industry [2].

The creation and use of electronic scientific editions took on special significance as the preferred method of scientific communication in education and science. The opportunity to publish the research results in electronic editions, especially on the internet, are of great interest for candidates for sciences and for the scientific community as a whole.

The Electronic Edition «Nanotechnologies in Construction: A Scientific Internet-Journal» has been included in the list of the leading review journals

налов и изданий, в которых должны быть опубликованы основные научные результаты диссертаций на соискание ученой степени доктора и кандидата наук (Решение Президиума Высшей аттестационной комиссии Министерства образования и науки Российской Федерации от 19 февраля 2010 года № 6/6).

Редакция Интернет-журнала «Нанотехнологии в строительстве» установила и поддерживает взаимодействие с РОСНАНО: на страницах издания публикуется информация о проектах, прошедших научно-техническую экспертизу в РОСНАНО; в издании открыта рубрика «Проекты РОСНАНО»; публикуются материалы о мероприятиях, организованных РОСНАНО.

Электронное издание «Нанотехнологии в строительстве: научный Интернет-журнал» получает всё большее распространение: журнал включен в систему Российского индекса научного цитирования, основная информация о статьях размещается на сайте Научной электронной библиотеки (www. elibrary.ru), что позволяет значительно расширить читательскую аудиторию. Интернет-журнал зарегистрирован в Регистре ISSN (International standard serial numbering) и внесен в международную систему данных по периодическим изданиям (МСДПИ) международного Центра ISSN в г. Париже (Франция); научный Интернет-журнал «Нанотехнологии в строительстве» и Интернет-портал NanoNewsNet совместно провели I Международную научно-практическую online-конференцию «Применение нанотехнологий в строительстве» (отчет опубликован в журнале 4/2009) и II Международную научно-практическую online-конференцию «Применение нанотехнологий в строительстве» (отчет опубликован в журнале 5/2010). Подтверж-

and editions in which the basic results of Ph.D. and Doctoral Theses are to be published. (The decision of Presidium of the Highest Certification Committee of Ministry of Education and Science of Russian Federation of 19 February 2010, № 6/6)

The editors of Internet-Journal «Nanotechnologies In Construction» have established and maintain the cooperation with RUSNANO: there is information about the projects undergone theoretical and practical examination in RUSNANO on the pages of edition; the column «RUSNANO Projects» has been launched; materials on the events organized by RUSNANO are published.

The Electronic Edition «Nanotechnologies in Construction: A Scientific Internet-Journal» is becoming more and more widespread. This journal has been included in the system of the Russian Index of Scientific Citation. The basic information within the articles is published at the website of the Scientific Electronic Library (www.elibrary.ru) therefore allowing greater access to a larger audience of readers. The Internet Journal is registered in the ISSN Register (International Standard Serial Numbering Register) and is included in the International Periodic Editions database (IPEDB) of the ISSN International Center in Paris, France. The Scientific Internet Journal «Nanotechnologies in Construction» and Internet-portal NanoNewsNet jointly held the 1st International theoretical and practical online-conference «Application of Nanotechnologies in the Construction Industry» (see a full report in journal 4/2009), the 2nd International theoretical and practical online-conference «Application of Nanotechnologies in Construction Industry» (see a full re-

дением тому, что издание становится всё более популярным в странах ближнего и дальнего зарубежья, стал также анализ посещаемости и использования материалов научного Интернет-журнала «Нанотехнологии в строительстве», проведенный редакцией по итогам 2010 года. Данные по количеству пользователей информации Интернет-журнала приведены в таблице.

port in journal 5/2010). The analysis of attendance and use of materials of Internet Journal «Nanotechnologies in Construction» which was carried out by the editorial staff summing up the results of 2010 has proved that the edition becomes more and more popular in the near and far countries abroad. Data on users of Internet-Journal information are given in the table below.

COUNTRY	2009	2010
Russian Federation	2226,00	44189,00
The USA	852,00	4606,00
Ukraine	60,00	1989,00
Netherlands	67,00	1313,00
Germany	1094,00	1183,00
Great Britain	38,00	729,00
Romania	53,00	634,00
Belarus	33,00	481,00
China	10,00	459,00
Kazakhstan	10,00	435,00
Spain	18,00	402,00
Norway	1,00	231,00
Mongolia	1,00	221,00
Poland	12,00	198,00
Italy	15,00	174,00
Latvia	26,00	141,00
Uzbekistan	5,00	128,00
Vietnam	1,00	117,00
Bulgaria	4,00	115,00
Kyrgyzstan	4,00	107,00
Switzerland	3,00	101,00
Belgium	1,00	90,00
Moldova	5,00	76,00
Iceland	1,00	66,00
Azerbaijan	4,00	64,00
Colombia	1,00	50,00
Lithuania	6,00	49,00
France	7,00	48,00
Bosnia and Herzegovina	8,00	46,00
Hungary	1,00	43,00
Sweden	1,00	41,00
Slovakia	1,00	39,00
Thailand	1,00	37,00
Estonia	2,00	34,00
Israel	12,00	31,00
Mexico	1,00	31,00
Greece	3,00	29,00

COUNTRY	2009	2010
Georgia	1,00	29,00
Iran	1,00	29,00
Indonesia	1,00	28,00
Canada	9,00	28,00
Japan	1,00	28,00
Brazil	1,00	26,00
Armenia	1,00	25,00
Finland	2,00	22,00
Taiwan (China)	1,00	21,00
Slovenia	1,00	20,00
India	1,00	19,00
Republic of Korea	1,00	17,00
Czech Republic	4,00	15,00
Singapore	1,00	13,00
Tajikistan	1,00	13,00
South Africa	1,00	13,00
Malaysia	1,00	11,00
Nigeria	1,00	9,00
Australia	2,00	8,00
Denmark	1,00	8,00
Luxembourg	1,00	5,00
Seychelles	1,00	5,00
Turkey	1,00	4,00
Philippines	1,00	4,00
Ireland	1,00	3,00
Austria	1,00	2,00
Argentina	1,00	2,00
Hong Kong	1,00	2,00
Jordan	1,00	2,00
Kenia	1,00	2,00
Egypt	1,00	1,00
Saudi Arabia	1,00	1,00
Albania	1,00	1,00
Monaco	1,00	1,00
Senegal	1,00	1,00
Tunisia	1,00	1,00
Turkmenistan	1,00	1,00

В настоящее время серьёзным препятствием публикации в издании материалов о своих достижениях зарубежными авторами является языковой барьер. Поэтому редакционный совет принял решение об изменении структуры материалов для авторов из-за рубежа:

- УДК;
- автор(ы): обязательное указание мест работы всех авторов, их должностей, ученых степеней, ученых званий (на английском языке и на русском языке);
- заглавие (на английском языке и на русском языке);
- аннотация (на английском языке и на русском языке);
- ключевые слова (на английском языке и на русском языке);
- **текст статьи (на английском языке);**
- библиографический список в формате, установленном журналом, из числа предусмотренных действующим ГОСТом (на английском языке и на русском языке);
- контактная информация для переписки (на английском языке и на русском языке).

Статья должна сопровождаться рецензией специалиста или рекомендацией организации. Примерная структура рецензии (рекомендации) приведена в Приложении 4 Перечня требований. Участие ведущих ученых и специалистов из-за рубежа позволяет значительно расширить площадку для обмена мнениями и получения самой передовой и достоверной информации о наноматериалах и нанотехнологиях [3].

Растет число мероприятий, в которых научный Интернет-журнал «Нанотехнологии в строительстве» принимает участие и информационную поддержку которых он осуществляет, а, соответ-

Today the serious obstacle for foreign authors to publish their materials on achievements in the Edition is language barrier. That's why the Editorial Council has made a decision to change the structure of materials for foreign authors to include:

- universal decimal classification;
- author(s)-it's obligatory to indicate the place of employment for all authors, their positions, scientific degrees, scientific titles (in English and Russian);
- title of the article (in English and Russian);
- annotation (in English and Russian);
- key words (in English and Russian);
- **text of the article (in English);**
- bibliographic list of references in the format provided by the journal of a list of State Industry Standard (in English and Russian), and;
- contact information for correspondence (in English and Russian).

The article should be accompanied by the review of a specialist or recommendation letter of organization. The example of the review (recommendation letter) is given in Appendix 4. The participation of foreign specialists allows greater on-site exchange of opinion, and the availability of up-to-date and reliable information on nanomaterials and nanotechnologies [3].

There is an increase in the number of events in which the Scientific Internet-Journal «Nanotechnologies in Construction» takes part and for which it provides information support, and therefore its

ственно, растет и авторитет издания [3]. Среди этих мероприятий:

- круглый стол «Нанотехнологии в строительстве: новые возможности для рынка», проведенный по инициативе ГК «Роснанотех» (г. Москва);
- Московский международный салон инноваций и инвестиций (г. Москва);
- международная специализированная выставка «Нанотехнологии» и международная научно-практическая конференция «Нанотехнологии и наноматериалы в промышленности» (г. Казань);
- научно-практическая конференция «Нанотехнологии – производству» (г. Фрязино Моск. обл.);
- международный симпозиум «Наноматериалы для защиты промышленных и подземных конструкций» и международная конференция «Физика твердого тела» (Республика Казахстан, г. Усть-Каменогорск)
- научно-практическая конференция «Нанотехнологии в строительстве» (г. Москва);
- международная конференция с элементами научной школы для молодёжи «Керамика и огнеупоры: перспективные решения и нанотехнологии» (БГТУ им. В.Г. Шухова, г. Белгород);
- II Съезд инженеров России и Всероссийская научно-техническая конференция по инновационным технологиям (г. Москва);
- международная «Цементная торговая конференция» (Турция, г. Стамбул);
- II Национальная Ассамблея «Стройиндустрия регионов России. Нанотехнологии в строительстве» (г. Москва);
- конкурс на соискание премии инноваций Сколково при поддержке Cisco I-Prize и др.

acceptance among similar editions has also increased [3]. Among these events include:

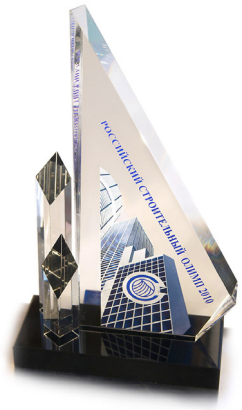
- a round-table discussion «Nanotechnologies in Construction: New Potential for Market», held by SC «Rosnanotech»s initiative (Moscow);
- Moscow International Salon of Innovations and Investments (Moscow);
- the international specialized exhibition «Nanotechnologies» and International Theoretical and Practical Conference on «Nanotechnologies and Nanomaterials in Industry» (Kazan);
- the Theoretical and Practical Conference on «Nanotechnologies for Production» (Fryazino, Moscow region);
- an international symposium entitled «Nanomaterials for Industrial and Underground Structures Protection» and an international conference entitled «The Physics of Solid Body» (East Kazakhstan, Ust-Kamenogorsk)
- Theoretical and Practical Conference on «Nanotechnologies in Construction» (Moscow);
- International conference with elements of scientific school for young people «Ceramics and Refractories: Perspective Solutions and Nanotechnologies» (Belgorod Shukhov State Technology University, Belgorod);
- II Congress of Russian Engineers and All-Russian Theoretical and Practical conference on innovative technologies (Moscow);
- International «Cement Trade Conference»(Turkey, Istanbul);
- II National Assembly «Construction of Russian Regions. Nanotechnology in Construction» (Moscow)
- Contest for award of Skolkovo innovations endorsed by Cisco I-Prize and others.

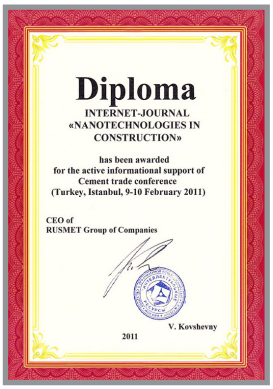
Среди участников и гостей мероприятий были руководители и специалисты организаций и предприятий, ученые, преподаватели вузов, сотрудники НИИ и научных центров из различных регионов России, стран ближнего и дальнего зарубежья, которые высоко оценили научно-технический уровень материалов и качество представления информации в издании.

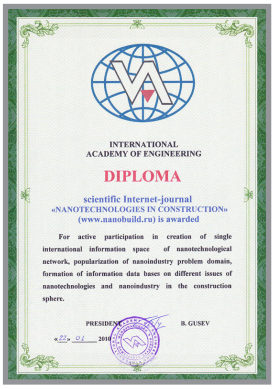
За активное продвижение высокотехнологической продукции (прежде всего – нанотехнологической) в области строительства и ЖКХ и участие в мероприятиях (форумах, конференциях, выставках и т. д.) Интернет-журнал отмечен знаком Высшего инженерного совета России «Инженерная доблесть», дипломами, сертификатами и благодарностями различных профессиональных и общественных организаций. Среди них: Российское общество инженеров строительства, Национальная ассоциация наноиндустрии, Московский комитет по науке и технологиям, Башкирский государственный университет, Международная инженерная академия, Белгородский государственный технологический университет им. В.Г. Шухова, Организаторы выставки «Изделия и технологии двойного назначения», Организаторы выставки «Нанотехнологии» и др. **Интернет-журнал «Нанотехнологии в строительстве» признан лауреатом премии «Российский Строительный Олимп-2010».**

Among the participants and guests at these events there were: directors and specialists of organizations and enterprises, scientists, lecturers, research officers of research centers from different regions of Russia and other countries which rated highly in the scientific and technical sophistication of their materials, and the quality of their information represented in the edition.

For the active promotion of high technological production (first of all – nanotechnological one) in the field of construction and housing and communal services and for the participation in events (forums, conferences, exhibitions etc.) Internet-Journal was awarded with the sign «Engineering Valour» of the Higher Engineer Council of Russian Federation, diplomas, certificates and gratitude from different professional and public organizations. Among them are: The Russian Society of Construction Engineers, National Association of Nanoindustry, The Moscow Committee on Science and Technology, Bashkir State University, International Engineering Academy, Belgorod Shukhov State Technology University, Board of International Exhibition «Products and Technologies of Dual Purpose», Board of Exhibition «Nanotechnologies» and other. **Internet-Journal «Nanotechnologies In Construction» has been recognized as the laureate of «Russian Construction Olympus – 2010».**







Основные принципы публикации материалов:

Компетентность.

На страницах журнала публикуются материалы ведущих российских и зарубежных ученых, профессорско-преподавательского состава вузов, сотрудников научно-исследовательских институтов и центров, конструкторских бюро, специалистов и консультан-

The basic principles of materials publication are:

Competence.

Examples include leading Russian and foreign scientists, teaching staffs of acclaimed universities, research officers of research institutes, centers and design offices, specialists and consultants (juristic and natural person) whose published materials appear on the pages of

тов (юридических и физических лиц); статьи сопровождаются рецензией специалиста, редакция предоставляет рецензии авторам рукописей и по запросам экспертных советов в Высшую аттестационную комиссию Министерства образования и науки Российской Федерации.

Публичность и открытость.

Информационные, аналитические и научно-технические материалы размещаются на сайте издания и на сайте Научной электронной библиотеки, краткая информация о публикациях (авторы, название публикаций, аннотации, ключевые слова и контактная информация) – на сайтах организаций, с которыми сотрудничает редакция. Это позволяет значительно расширить площадку для обмена мнениями и получения самой передовой и достоверной информации о наноматериалах и нанотехнологиях.

Независимость.

Редакция действует самостоятельно в рамках законодательства Российской Федерации, в соответствии с Законом Российской Федерации «О средствах массовой информации» (№ 2124 от 27.12.91 г.), а также решений редакции журнала.

the Journal; articles which are presented on demand and are peer-reviewed by editors of the Highest Certification Committee at the Ministry of Education and Science of The Russian Federation.

Publicity and Transparency.

Information, and analytical and scientific technical data are placed on the website of the Edition and Scientific Electronic Library, brief description about publications (authors, title, annotation, key words and contact information) – at the websites of organizations cooperating with the editorial staff. This allows greater on-site exchange of opinion, and the availability of up-to-date and reliable information on nanomaterials and nanotechnologies.

Independence.

Editorial staff acts independently within the legal requirements of the Russian Federation according to the Law of The Russian Federation «On Mass Media» (№ 2124 of 27.12.91) as well as editorial staff decision.

Основная тематика публикуемых материалов:

- Разработка теории формирования прочности и проницаемости наноструктурированных систем.
- Математические квантовые и другие виды моделей для исследования свойств наноматериалов.
- Проблемы применения наноматериалов и нанотехнологий в строительстве и строительных материалах.

The basic themes of published materials are:

- Nanostructured systems strength and penetrability formation theory development.
- Mathematical quantum and other types of models for nanomaterials characteristic research.
- The problems of nanomaterials and nanotechnologies implementation in construction and building materials.

- Технологические принципы создания наноструктур (расплавы, золь-гелевый синтез и др.).
- Создание новых функциональных материалов в строительстве.
- Разработка принципов перехода «беспорядок-порядок» при создании композитов с использованием синергетики и других подходов.
- Изучение различных технологических принципов при создании наносистем в промышленном производстве.
- Диагностика наноструктур и наноматериалов строительных систем.
- Проблемы получения высокоплотных и высокопрочных строительных материалов (бетоны, керамика и др.).
- Технологии измельчения минеральных частиц до наноразмерных уровней.
- Технология перемешивания смесей с нанодисперсными частицами и методы их активации.
- Гидродинамические и другие методы активации водных суспензий и растворов.
- Модификация водных растворов различных наноразмерных добавок, используемых в строительстве.
- Исследование в области токсичности порошковых наноматериалов.
- Металлическая арматура, модифицированная в процессе изготовления наноразмерными материалами.
- Волокна углеродные, базальтовые, арамидные и другие малых диаметров с наноразмерными структурными характеристиками.
- Цементные и другие вяжущие с минеральными и органическими добавками.
- Бетоны и растворы, модифицированные наноразмерными добавками.

- Technological principles of nanostructures creation (liquid melts, sol and gel synthesis).
- Creation of new functional materials in construction.
- Development of transition principles «disorder-order» under creation of composites using synergetic and other approaches.
- Study of different technological principles under creation of nanosystems in industrial production.
- Diagnostics of building systems nanostructures and nanomaterials.
- The problems of obtaining of high-density and high-durability building materials (concretes, ceramics and so on).
- Technologies of mineral particles grinding to nanosize levels.
- Technology of blending mixtures containing nanodispersed particles and methods of their activation.
- Hydrodynamic methods and other methods of aqueous suspensions and solutions activation.
- Modification of aqueous solution of different nanosize additives used in construction.
- Research in powder nanomaterials toxicity area.
- Metal reinforcement modified by nanosize materials during the manufacturing.
- Fibers carbonic, basalt, aramid and other of small diameters with nanosize structural characteristics.
- Cement and other astringents with mineral and organic additives.
- Concretes and solutions modified by nanosize additives.
- Mineral particles suspensions used for laques, paints as well as modifiers for concretes and solutions, properties, fabrication method and durability.

- Суспензии минеральных частиц, используемые для лаков, красок, а также модификаторов к бетонам и растворам, свойства, технология их приготовления и живучесть.
- Дисперсии органических материалов, используемые для изготовления лаков и красок, а также добавок для бетонов и растворов, методы их активации и живучесть.
- Применение нанопорошков различной природы для модификации свойств строительных материалов.
- Новые свойства строительных материалов на основе наносистем.
- Модифицирование строительных материалов нановолокнами.
- Дисперсные композиционные материалы с нанопокрытием.
- Формирование наноструктурных покрытий лазерным напылением.
- Разработка методов исследования наноструктуры материалов на основе дисперсных систем, в том числе исследования нанообъектов пустоты в пористых системах.
- Технологии исследования свойств наноматериалов.
- Системы преподавания основ нанотехнологий.

Тематика статей может быть и иной, прямо или косвенно связанной с перечисленными выше направлениями [4].

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- Organic materials dispersions used in laques and paints production as well as for concretes and solutions additives, methods of their activation and durability.
- Use of nanopowder of different nature for building materials properties modification.
- New characteristics of building materials on the basis of nanosystems.
- Modification of building materials by nanofibers.
- Disperse composite materials with nanocoatings.
- Formation of nanostructure coatings by means of laser sputtering.
- Development of materials nanostructure research methods on the basis of disperse systems.
- Building materials properties research technologies.
- The systems of teaching the fundamentals of nanotechnologies.

The theme may be different, directly or indirectly associated with the directions given above [4].

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Следует отметить и то, что в Интернет-журнале «Нанотехнологии в строительстве» выгодно размещение не только научных, но и рекламных материалов компаний по следующим причинам:

«Читабельность» издания. В журнале публикуют информацию о своих достижениях ведущие ученые, сотрудники научно-исследовательских институтов и научных центров, руководители и специалисты организаций и предприятий, предприниматели. Качество публикуемых материалов и большая популярность в настоящее время нанотехнологий привлекает внимание всех, кто заинтересован в создании благоприятных условий по увеличению производства и объема продукции в области строительства, выходу организаций на мировой рынок высоких технологий и завоеванию на нем лидирующих позиций.

Наличие полнотекстовой версии материалов в Интернете в свободном доступе в любой точке земного шара, причем, чем раньше материалы будут размещены, тем более длительное время они будут «работать».

Участие фирм в создании единого информационного пространства международной нанотехнологической сети, организации разработки и формирования информационных баз данных по различным вопросам нанотехнологий и наноиндустрии в области строительства.

Возможность выхода при чтении материала в издании непосредственно на сайты фирм за счет активной ссылки.

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It should be noted that there are several reasons why it is profitable to place not only scientific articles but also advertisement in Internet-Journal «Nanotechnologies in Construction»:

The audience of the edition. Leading scientists, research officers of different centers and institutes, chiefs and specialists of organizations and enterprises, and businessmen publish information on their achievements in the Journal. The high quality of published materials and great popularity of nanotechnologies at present attracts the attention of those who are interested in creating favorable conditions that increase the total output of production at the construction site, and who want to dominate the market of high technologies.

Availability of full-text version of materials in Internet in free access in any place of the world. The sooner materials are published increases the likelihood that they will «work».

Various firms' participation in the creation of a single international informational internet website focused on nanotechnologies. This facilitates the organization and development of information databases on relevant issues, and.

The opportunity to go directly to the firms' website using active link.

По просьбе авторов и читателей на издание организована подписка. Подписаться можно на журналы 2009 года (4 выпуска), на журналы 2010 года (6 выпусков) и на журналы 2011 года (6 выпусков):

– в редакции издания (подробности на сайте **www.nanobuild.ru**);

– в Научной электронной библиотеке **(www. elibrary.ru)**.

Редакция предлагает подписаться на издание и приглашает ведущих ученых, руководителей и специалистов организаций и предприятий из России и зарубежных партнеров к публикации материалов научно-практического и рекламного характера в научном Интернет-журнале «Нанотехнологии в строительстве».

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С учетом имеющегося опыта редакция Интернет-журнала «Нанотехнологии в строительстве» готова совместно с организациями (крупными компаниями, ассоциациями, партнерствами и др.) создавать и развивать собственные Интернет-издания организаций, ассоциаций, партнерств и др.

Значительных успехов в становлении и развитии электронного издания «Нанотехнологии в строительстве: научный Интернет-журнал» за столь короткий период времени удалось достигнуть благодаря высокому качеству авторских материалов, активной помощи членов редсовета и редколлегии, руководителей и специалистов организаций-партнёров, добросовестной работе сотрудников редакции. Ког-

At the request of various authors and readers a subscription for Journal was created. Subscribers can have access to journals from 2009 (4 issues), for journals from 2010 (6 issues) and for journals from 2011 (6 issues):

– in editorial office (see details on the website **www.nanobuild.ru**);

– in Scientific electronic library **(www. elibrary.ru)**.

The editors offer subscriptions for edition and invite leading scientists, chiefs and specialists of Russian organizations and enterprises and foreign partners to publish theoretical and practical materials as well as advertisement in the Scientific Internet-Journal «Nanotechnologies in Construction».

You can see edition contents and a list of requirements for materials at **www.nanobuild.ru.** If you have any questions on materials publication contact us by **e-mail at: info@nanobuild.ru.**

Considering the experience of the editorial staff of Internet-Journal «Nanotechnologies in Construction» we are ready to create and develop jointly organizations', associations', partnerships' own Internet-editions.

The CONSIDERABLE success in establishing and development of the electronic edition «Nanotechnologies in Construction: A Scientific Internet-Journal» within a rather short period of time was possible due to high quality of authors' materials, active assistance of editorial council members...

When we see that our common efforts give visible results that becomes the best award for the work we have done.

да мы видим, что наши общие усилия находят реальное воплощение, это становится самой большой наградой за проделанную работу.

Надеемся на плодотворное и взаимовыгодное сотрудничество и в дальнейшем!

We hope for effective and mutual beneficial cooperation!

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VYACHESLAV RUVIMOVICH FALIKMAN – INTERNATIONALLY RENOWNED RUSSIAN SCIENTIST AND PUBLIC MAN

УДК 691.3, 666.98

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ENVIRONMENTALLY ACTIVE GRC: TOWARDS BETTER APPEARANCE OF CONCRETE AND A REDUCTION OF AIR-POLLUTION IN URBAN ENVIRONMENT

Following a brief review of the GRC as probably the most complex of construction materials, the focus is on a new, *environmentally active glassfibre reinforced concrete: e-GRC*. Introduction of the *e-GRC* represents a very significant and novel contribution to concrete practice, at a stage when the scientific and practical proof of the concept has been obtained but the technology has not yet reached the construction marketplace.

Development of the e-GRC represents the third successful application of nanotechnology in GRC, unmatched in any other common construction material. It is based on a finding that a reduction in size of particles of a material down to nano-size often imparts new or enhances their existing properties. This is typical of nano-particles of titanium dioxide, which maintains its strong photocatalytic activity even when mixed with cement. External cement-based surfaces therefore become strongly photocatalytic, leading to a much better appearance through a 'de-soiling' effect together with a significant reduction in concentration of pollutants in the surrounding air. Traditional GRC is already mostly produced as thin-walled elements with large exposed surface and presents itself as an excellent material for practical exploitation of the photocatalysis. As only surfaces are active, the e-GRC also provides the most efficient use of the nano-sized titanium dioxide. *The e-GRC therefore offers an economical and sustainable way to achieve long-lasting, cleaner and brighter concrete surfaces and a new way of achieving a significant reduction in pollution levels of surrounding urban environment*. It provides architects with an additional tool to design and build genuinely 'greener' and better-looking concrete buildings. The e-GRC has a potential to improve the often poor general image of concrete, which tends to be associated with dirty buildings in polluted urban 'concrete jungles'. Benefits offered by the e-GRC indicate a more sustainable concrete construction with a direct and positive environmental impact is possible.

Key-words: environmentally active glassfibre reinforced concrete, composite materials, concrete matrix, nanoparticles, titanium dioxide, photocatalysis, self-cleaning capability, de-polluting of the air.

1. What is GRC?

First attempts to produce concrete reinforced with glass fibres had been made by Biryukovich and Biryukovich [1] in what was the USSR. They tried ordinary (E-glass) fibres, which were then commonly used as reinforcement of polymeric matrices. However, this type of fibre was not durable when embedded in a highly alkaline cement-based matrix, the composite lost strength with ageing. Attempts to improve durability by using special cements then available to produce a low-alkali matrix were unsuccessful. Development of durable GRC which was suitable for practical use had to wait until an alkali-resistant (AR-glass) was invented at Pilkington Ltd (Tallentire et al.) in collaboration with the Building Research Station (Majumdar et al.) in Britain in late 1960s [2].

Glassfibre reinforced concrete is a composite in which both the matrix and the reinforcement are complex composites themselves. To make it yet more complicated, internal microstructure, properties of both the matrix and reinforcement and bond between components of the composite, all change with time and conditions of service environment in a non-linear way. GRC is probably the most complex of construction materials currently in general use.

Concrete matrix: The GRC matrix consists of a fine mortar (aggregate size ≤ 1.5mm), based mostly on OPCs but other cementitious binders can be used. It shows a complex rheological behaviour when fresh, especially when a spray-up production process is used which often begins with a high-shear mixing of the fresh matrix material. Superplasticisers, namely of the second-generation type developed for self-compacting concrete using nanotechnology, are usually added in order to reduce the water content but maintain a very high fluidity of the fresh matrix. Almost all GRC also contains a small proportion of another polymer (usually an acrylic compound) to facilitate curing and prevent early loss of moisture. When hardened, mechanical properties and dimensions of the matrix (and of the composite

itself) continue to change with time, environment and load in a non-linear and partly reversible manner.

Reinforcement: The basic reinforcement is not in the form of single solid individual fibres, as is the case in almost all other industrial fibrous composites. Instead, it consists of strands/bundles of varying size (Fig.1), shape, length and cross-section, containing a very large number of very thin glass filaments (10–15 μm dia.). The basic reinforcing elements are therefore the fibre strands, which are complex composites themselves; their properties also change with time and external exposure. Tensile strength of individual glass filaments is variable and highly dependent on their defect-free surfaces, the fibres within a bundle are therefore coated during manufacture to avoid damage when bundled together. The reinforcement (strand) is usually cut before or during GRC production to a pre-determined length, usually between 5mm to 50mm. It is incorporated into the matrix in different shapes and orientations; its distribution varies from a 3-D random distribution of chopped strands, to highly directional ones (e.g. in mats and fabrics) where long strands are used [3].

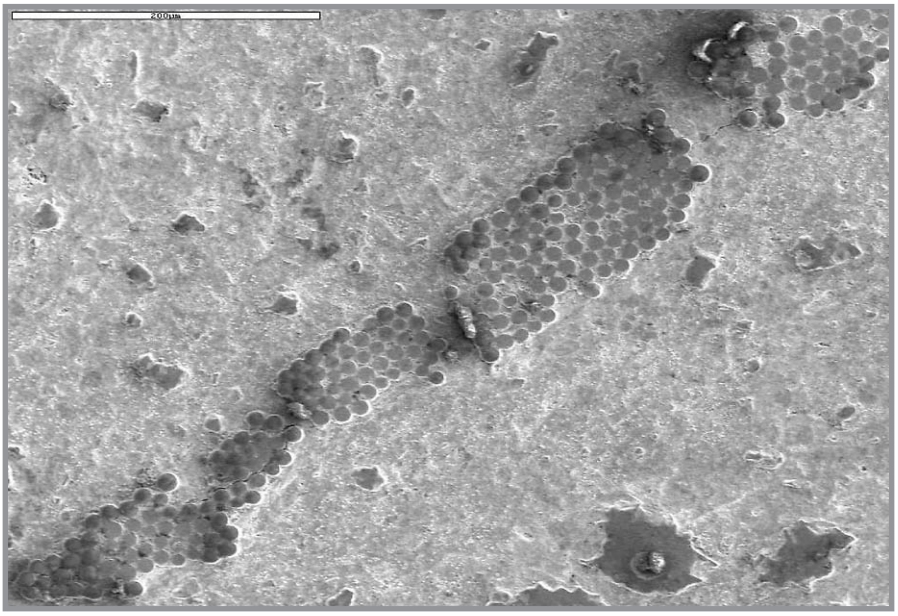

Fig. 1. **Bundles of glass fibres (10 mm dia.) embedded in a cement matrix.**

Note: A few individual fibres separated during production of GRC but most fibres remained in larger bundles – such a fibre distribution is unique to GRC

A complex mechanism exists for transfer of stress/load and its sharing between matrix and reinforcement. Strength, deformability, quantity, length and orientation of reinforcement do matter. The effectiveness of the fibre strands in producing desired performance of GRC also depends very strongly on bond [4, 5], which acts on two types of interfaces:

- Between strands/bundles and the matrix
- Between individual fibres within a bundle

The effect of bond on the type of fracture mechanism is illustrated in Fig. 2:

- The strand on the left comprises tightly packed fibres, well bonded within a strand. The strand itself is bonded poorly to the matrix. At failure, an almost complete pullout of the whole strand occurs; the fibres are poorly utilized. Work of fracture is very low.
- The strand in the middle displays a typical '*telescopic*' failure, identified first by Bartos [4, 5, 6]. The telescopic failure occurs when outer/peripheral fibres in the strand mostly fracture in tension (well bonded to matrix) while the inner, core fibres inside of the strand, pull out and fracture in stages. The highest amount of work of fracture is consumed in this mode of fracture.

  The telescopic mode of fracture is the preferred one: reinforcement behaving in this way can improve both strength *and* toughness of the GRC. However, the telescopic mode of fracture of ordinary GRC is normally observed only in its early stage of ageing [6], before bond between fibres inside a strand becomes too high.
- The strand on the right shows a case of good bond both within the strand (as in the strand on the left) but also a very good bond between the strand and the matrix. This exploits fully the strength of the strand but it causes the strand to fracture as a whole, in an undesirable brittle manner. The work of fracture is low.

Research into microstructure of GRC aims to measure the bond (both within a strand, and between strand and matrix) and then to develop means of controlling the bond at predetermined levels. The overall aim is to maximise mechanical properties of GRC and maintain them over its expected service life, to avoid bond rising excessively with age – leading to embrittlement of the whole composite. The earliest work, carried out

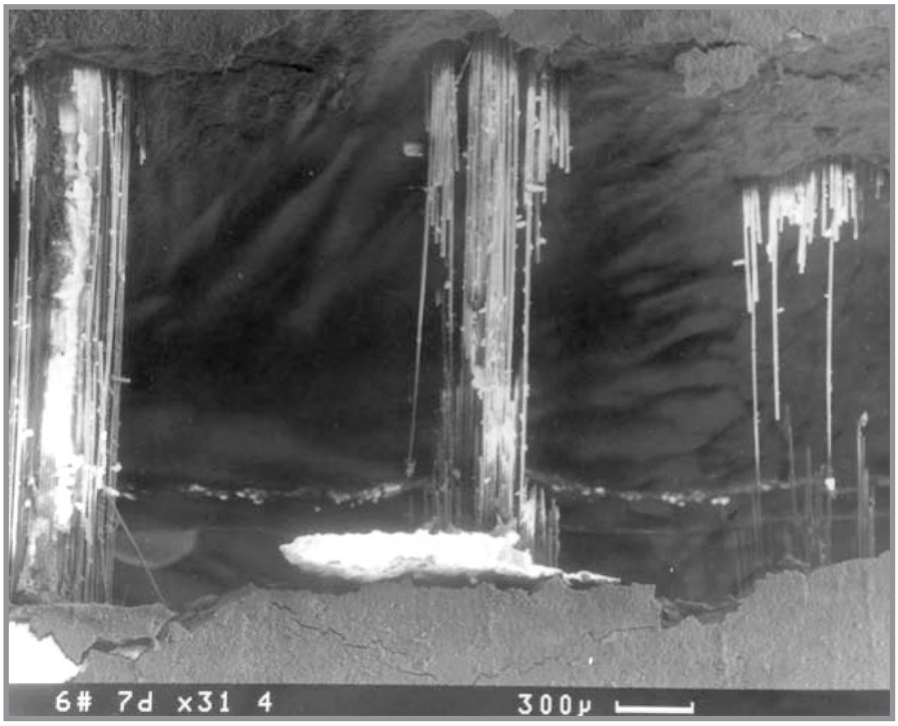

Fig. 2. **A composite picture showing three microphotographs taken from an in-situ SEM tensile tests showing different modes of failure of glass strands bridging a crack in cement matrix**

by Bartos [3, 4] established the basic understanding of the micro-fracture mechanisms involved were established. However, progress in this direction had been constrained until developments in nanotechnology provided novel tools for advance towards stronger and tougher GRC. It led to pioneering applications of nanotechnology (e.g. first development of nano-indentation) used in the study of internal bond and microfracture mechanisms of GRC (1994- P.J.M.Bartos, W.Zhu, P.Trtik et al., University of Paisley – now U. of West of Scotland) [7, 8]. Nanotechnology allowed application of loads with accuracy of 1 mN while displacement was continually monitored with a resolution of a nm. Current research continues, with most recent work being carried out at the ibac centre of the RWTH in Aachen [9].

The original aim of moving from a better understanding towards applications by the control of the fracture mechanism and thus a greater exploitation of the substantial 'high-tech' potential of the GRC is still being pursued.

2. Photocatalysis and concrete

2.1. Photocatalytic and hydrophilic activity

Photocatalysis is a well know natural phenomenon: life on earth as we know it depends strongly on photocatalytic reactions involved in photosynthesis, generated by sunlight.

Scientific research into photocatalysis has continued for several decades. A number of materials that show photocatalytic behaviour have been identified and research still continues. Great attention has focused on possibilities of using photocatalysis for oxidation and breaking-down of organic and inorganic pollutants. The oxidation capability was shown to be strong enough to cause destruction of biological matter and this was exploited as 'antibacterial action'. Initial practical applications were aimed at purification of water and exploitation of the strong photocatalytic action in medical practice and in health-related industry. However, many other applications have emerged in the last decade, mostly in the form of surface technology, developing photocatalytic coatings on glass, metals and textiles, and used as active paints on many consumer products.

Nanotechnology began to be commercially exploited since the beginning of 1990's, alongside the increased research into photocatalysis. Nanotechnology-based techniques permitted reduction of size of particles of many materials down to the nano-scale. It was soon observed that such a reduction in size often imparted new or enhanced existing properties of such materials. This has been also demonstrated in the case of titanium dioxide (TiO_2).

Titanium dioxide is a relatively abundant material, which exists in several forms. The most common form is Rutile, which has been used to for many decades to give whiteness to white paints and in many other products. It has been also known that Anatase, another form of the TiO_2, behaved as a semi-conducting material and showed a substantial photocatalytic activity. This was investigated from 1970's, particularly in Japan. However, it was only after the advent of nanotechnology permitted Anatase to be produced in nano-sized particles. The reduction to nano-size greatly enhanced its photocatalytic activity. Research into TiO_2 continues and new forms are being discovered [10].

The photocatalytic action is generated by ultraviolet rays (UV-A part of the spectrum of natural daylight), which interact with the nano-crystalline lattice structure of the Anatase version of the titanium dioxide. In presence of moisture (water), very highly reactive radicals such as O_{2-} and OH are produced on the irradiated surfaces. A broad range of organic and inorganic chemical compounds, both as solids and in the form of liquid or gases undergo an oxidative destruction when in contact with strongly photocatalytic surfaces in a complex process. These include many of the typical constituents of airborne pollution, which are known to have adverse effect on human health, namely in densely populated urban centres and industrial zones. Typical pollutants include nitrogen oxides (NO_x), sulphur oxides (SO_x), usually in a gas form and numerous organic compounds such as volatile organic compounds (VOC's), formaldehyde, toluene etc. in both gas and liquid forms. Pollution also affects directly other living organisms such as animals and plants and its secondary effects include acceleration of deterioration of construction materials.

It was discovered more recently, that the photocatalytic activity of the nano-crystalline form of Anatase also affects the hydrophobic properties of the surface. The irradiation with UV light changes the original hydrophobic surface (high contact angle, repelling water) into a very highly hydrophilic one (low contact angle, water adheres and spreads). The degree of hydrophylicity, expressed by the contact angle between the surface and the liquid (water) in contact with it, has been reduced to less than 5°, inducing a 'super-hydrophylicity' [10]. This is demonstrated by formation of a very thin, uniform film of water on the exposed photocatalytic surface. The water layer appears to hinder adhesion of external substances to the surface and thus helps to maintain the surface clean.

The combination of a strong destructive oxidation and superhydrophilicity generated by photocatalytic TiO_2 provides active surfaces, which not only break down many important gaseous liquid and particulate pollutants but also reduce significantly adhesion of all particles (dust) to the surface of a cementitious material such as the e-GRC. A significant 'self-cleaning' capability is generated.

It is therefore possible to identify two basic and simultaneous mechanisms involved in the self-cleaning process:

(a) Particles of organic dirt are broken down in the photocatalytic process.

(b) The superhydrophilicity generated by the activation of the TiO_2 reduces the possibility of adhesion of the un-broken organic pollutants to the surface

(c) The (a) and (b) above combine to reduce the opportunity for inorganic particles (dust), unaffected by the photocatalysis itself, to settle on the surface (especially when vertical). The active surface then contains fewer 'sticky' organic particles to which particles of inorganic dust can easily adhere.

Fig. 3 illustrates the processes involved.

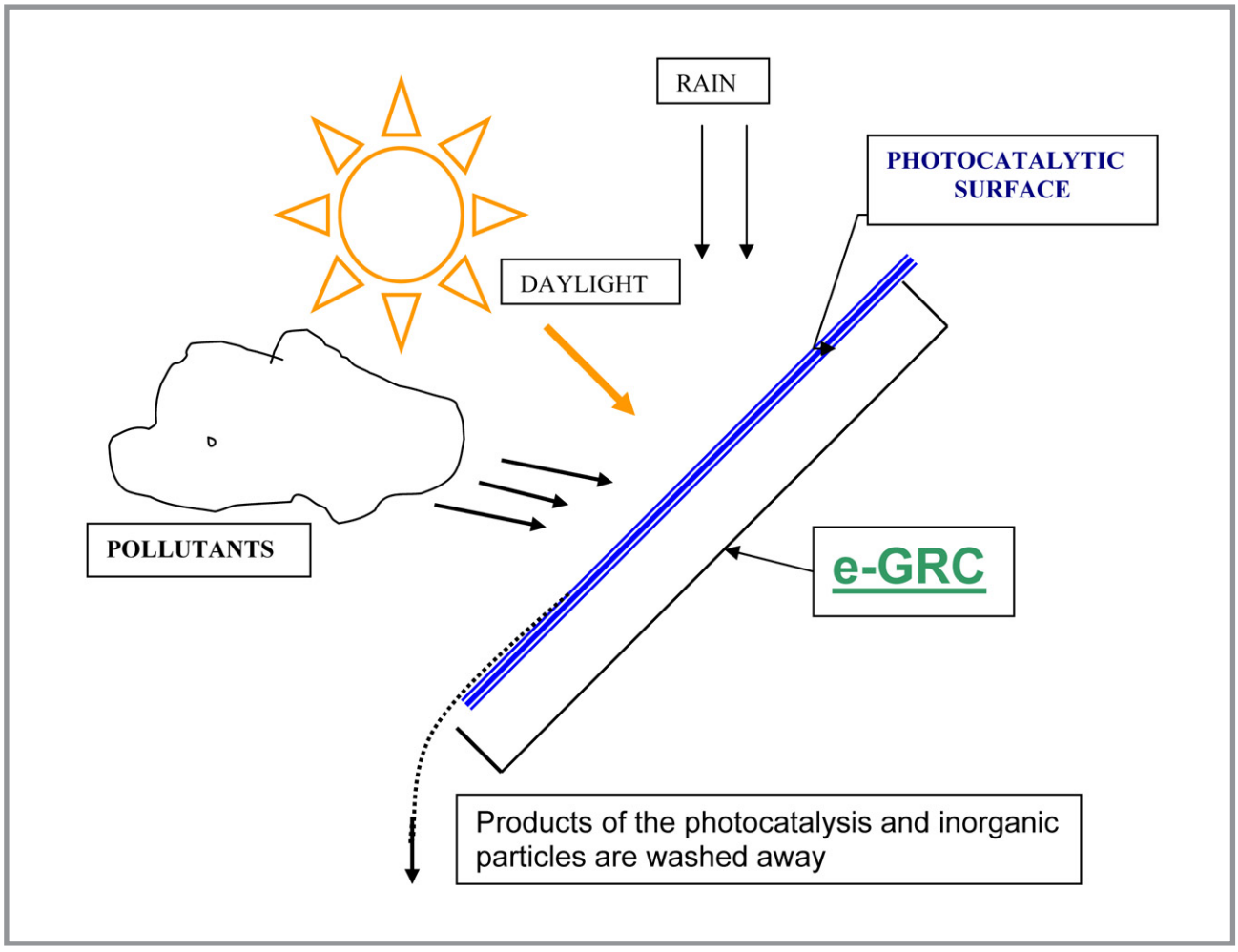

Fig. 3. **Basic outline of the photocatalytic activity at exposed e-GRC surface**

2.2. Photocatalysis and concrete

First commercial applications of photoactive TiO_2 in built environment were in Japan, where it was used as a coating on ceramic building products, making them not only self-cleaning but also anti-bacterial and 'self-disinfecting' (e.g. sanitary ware).

The idea of combining the inert but photoactive TiO_2 with cement in order to produce photocatalytic concrete or active coatings for concrete was explored by the European project PICADA [11], which ended in 2005. Indeed, a cement binder containing approx. 5 % of active TiO_2, produced concrete with a photocatalytic surface. Moreover, a degree of synergy was observed: the cement based matrix appeared to assist in conversion of the noxious pollutants and their removal from surrounding air.

Pollutants which are oxidised and/or broken-up and their concentrations in air much reduced by the photocatalytic action of the cement-TiO_2 system include: NO_x; SO_x; CO; NH_3 and a number of often volatile organic compounds such as benzene, toluene, acetaldehyde, formaldehyde, organic chlorides etc [12, 13]. The process of oxidation and breaking down of pollutants is a complex one, beyond the scope of this paper. In case of harmful nitric oxides, the NO_x are oxidised to NO_2 and then bound into nitrates, which are washed away by rain. Organic compounds tend to be broken down, some right down to CO_2 and water. Depending on the strength of the UV irradiation in the daylight, up to 90 % of organic compounds can be eliminated from the air.

The PICADA consortium carried out both laboratory tests, including large environmental simulation chambers and full-scale outdoor trials (see Figs. 4, 5, 6) to assess the ***de-polluting and self-cleaning capability of the photocatalytic concrete***.

Results were very encouraging; urban trials in Italy in November 2006 [11] produced reductions of NO_x content in air varying between 26 to 56 % after an 8-hour period of daylight exposure. Nitric oxides are a significant health hazard generating respiratory problems.

The photocatalysis also applies to many, mainly organic, pollutants in particulate or liquid form, which are deposited on exposed surfaces and contribute greatly to soiling of facades. Photocatalytic action helps to break down such pollutants and soiling agents and assists in maintaining the original appearance of the concrete surface.

Fig. 4. **Fasade of the building of the Cité de la Musique et des Beaux Arts; Chambéry, France, built using photocatalytic concrete (Photo PJM Bartos, 3/2008)**

Fig. 5. **Detail of the photocatalytic concrete facade after 8 years of exposure. Building of the Cité de la Musique et des Beaux Arts; Chambéry, France**

The efficiency of this process, usually called '*self-cleaning*', was also tried in experiments, where surfaces of cementitious specimens were treated with different types of 'organic dirt'. The specimens were exposed to both variable daylight and controlled artificial UV exposure and the speed and degree of decomposition of the dirt, and the recovery of the original surface appearance were measured.

Results were very encouraging again, and full-scale trials on buildings built using photocatalytic concrete and on buildings with facades rendered using an active cement mortar were then also carried out, mostly as part of the PICADA project [11]

The longest period of monitoring performance of photocatalytic concrete has been on the building of the Cité de la Musique et des Beaux Arts in the centre of the city of Chambéry in France (Figs. 4, 5). The multistory in-situ concrete structure was completed in yr. 2000 and the quality of the exposed external concrete surfaces have been monitored in a number of different locations on the structure ever since. The quality and appearance of the concrete surfaces have remained virtually unchanged to date, as the au-

thor's own visit in 2008 confirmed: after eight years in service, the structure looked as if it were freshly built (Fig. 6).

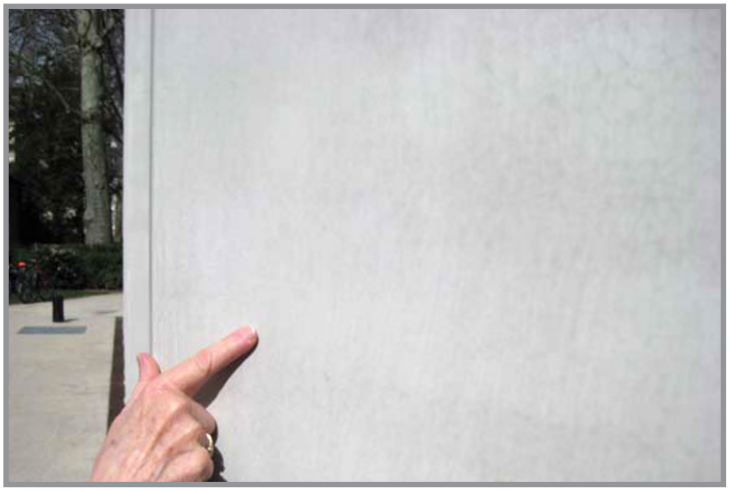

Fig. 6. **Photocatalytic surface of concrete of the building of the Cité de la Musique et des Beaux Arts; Chambéry, France, examined in March 2008. Note the perfect surface finish, with almost no accumulated dirt. (Photo P.J.M. Bartos)**

Practical experience obtained suggests that although the photocatalysis cannot break-down inorganic soiling agents such as mineral dust, the super-hydrophyllicity generated during breakdown of organic compounds makes the concrete surface less adherent for the inorganic dust. As a result, the soiling overall is reduced much more than a mere removal of the organic compounds would indicate.

The photocatalytic cement, originally produced by Italcementi [14] and recently licensed to other cement-makers (e.g. Heidelberger Cement), has been already used in other concrete buildings in Italy and France. The most notable example is the Church of "Dives in Misericordia" in Rome, designed by Richard Meier and completed in 2003. The active TiO2 has ensured that the brilliant white surfaces of the striking white-concrete shapes of the church (Fig.7) will remain shining bright much longer than what would be expected in such a relatively polluted urban environment. Performance of the photocatalytic exposed concrete surfaces to-date has been excellent in all the practical applications to-date.

3. e-GRC: cleaner surfaces and less pollution – a positive contribution to environment

There is now sufficient scientific and practical evidence that the concept of mixing active TiO_2 with cement produces a binder, which maintains all its normal performance characteristics when used to make concrete. However, in addition, it also produces surfaces exhibiting strong photocatalytic activity. The photocatalytic action makes the surfaces not only to a significant degree 'self-cleaning'; it also improves the quality of the surrounding environment.

Initial research was focused either on 'photo-activating' bulk concrete or on trying 'photo-active' coatings for ordinary concrete structures [14]. However, it is clear that using 'TiO_2-cement' blend as binder for in-situ bulk (reinforced) concrete wastes the 'active ingredient'. Precast concrete can be made in such a manner that the TiO_2 would be present only in a 'surface layer'. However, such approach requires more complicated and inconvenient production methods, which increase costs and reduce productivity. Using 'active' coatings for concrete surfaces leads to inevitable problems of reliability and durability of such coatings and their adhesion to the substrate. The construction process also becomes longer and productivity decreases.

Fig. 7. **Precast and in-situ photocatalytic white concrete. *Dives di Misericordia* church in Rome (architect: R.Meier). (Dr A Skarendahl [15])**

Using TiO_2 in glassfibre reinforced concrete logically offers the most efficient and economical way to exploit the benefits of photocatalysis. This leads to the *environmentally active GRC: the* ***e-GRC***, which is based on a well-established production process for manufacture of thin-walled construction elements, usually with a very high surface to volume ratios [16]. The content of the active ingredient is reduced, it can be either in the basic matrix or, even more economically, just in the 1–2 mm surface layer, which is routinely sprayed first into GRC moulds.

The ever-increasing demands on quality of environment support strongly the moves to make most of the positive environmental contribution of photocatalysis imparted to cement-based products by the TiO_2. However, the introduction of photocatalytic concrete surfaces *must be also sustainable – minimising the demand for active* TiO_2 *while maximising the benefits from its use*. Such a consideration inevitably points to a strong future demand for the *e-GRC. The e-GRC offers the most economical way to achieve cleaner, brighter facades and significantly contribute to reduction in pollution of urban environment* [16].

There are many applications for the e-GRC, including:

- ✓ Cladding panels & facade elements
- ✓ Permanent formwork & form-liners for practically all concrete surfaces to be exposed to outdoor environment
- ✓ Roofing tiles / slates
- ✓ Street furniture
- ✓ Motorway and railway sound barriers, screens and safety barriers

The concept of the photocatalytic concrete surfaces now being well proven, the International Glass Reinforced Concrete Association (GRCA), a special interest group within the UK Concrete Society and its members are considering actions needed to bring the e-GRC to the construction market. These include production of guidelines both for practical manufacture of e-GRC and for its use and guidelines for its specification and verification by the architects and anyone else developing ecologically conscious built environment. First attempts at using e-GRC as architectural cladding on full-scale structures have started and the building shown in Figure 8 [13] has been recently completed.

Fig. 8. **Practical application of e-GRC by Grupo Nord, a GRCA member company [13] (completed in 2010)**

4. Conclusions

Introduction of the ***e-GRC*** offers unique benefits for construction industry, for the built environment at large a for the society as a whole.

The principal benefits include:

- Much better appearance, namely brightness of colour, of exposed, external surfaces of concrete structures, which will last much longer than before, combined with the outstanding freedom of shape size and colour of GRC, already enjoyed by architects and other end-users.
- Better quality of air, especially in congested urban centres enjoyed by population at large

There are no serious technical limitations to introduction of the ***e-GRC*** and no significant health hazards are associated with the photocatalytic TiO2 [17].

The active ingredient in e-GRC is not consumed during photocatalysis, its active life is not diminished by age, making it an even more sustainable product.

Indications are that the ***e-GRC*** will help concrete to shed its old image of a grey and dirty material. It will become a genuinely environmentally friendly material contributing not only by its better appearance but also by its positive environmental impact to a higher quality of urban life.

Dear colleagues!
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РОСНАНО

RUSNANO Projects

RUSNANO – THE LARGE-SCALE STATE PROJECT

УДК 666.3-128

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NANOGLASSCERAMIC MATERIALS ON THE BASIS OF EULYTITE TYPE GLASSES CONTAINING PENTOXIDE

Nanoglassceramic materials were obtained using directional crystallization of eulytite type glasses on the basis of addition of pentoxide. Average sizes of crystal phase of eulytite $Bi_4Si_3O_{12}$ are 40 nm (for glasses which time melting is 2 h. 10 min.) and 50 nm (for glasses which time melting is 1 h.).

Key-words: nanoglassceramic materials, crystal phase, silicoeulytite.

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RESEARCHES, DEVELOPMENTS, PATENTS

УДК 69

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METHOD FOR INTRODUCING BASALT FIBER INTO COMPOSITE MATERIALS

The analysis of the patent information about the methods of incorporating nanoadditives into composite materials is given. Inventions can be applied in building technologies to produce nanomodified composite materials on the basis of air and hydraulic binders. That will allow considerable intensification of industrial manufacture of nanomodified composite materials due to implementation of new method of incorporating nanoadditives on a basalt fiber and provide widening of nanoadditives assortment as well as the use of new kinds of fibers.

Key-words: patent, invention, methods of incorporating, nanoadditives, nanomodified, air-setting and hydraulic binder, fiber, composite materials.

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IN THE WORLD OF THE BOOKS

SCIENTIFIC AND TECHNICAL LITERATURE. NANOMATERIALS AND NANOTECHNOLOGIES

Some information on the books proposed by the limited company «Techinform» in the sphere of nanomaterials and nanotechnologies is given.

Key-words: vacuum plasmachemical processes, nanotechnologies, nanoobjects, nanocrystal materials, micro- and nanodimensional devices, autoemission structures, nanoelectronics.