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Russian Nanoscience: Bibliometric Analysis Relying on the STN International Database

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Abstract

Russian investigations in the area of nanoscience and nanotechnology were studied by means of bibliometric methods using the databases of Science Citation Index, Chemical Abstracts and Inspec of the international research network Scientific and Technical International.

Key words: databases, bibliometric analysis, nanoscience and nanotechnology, Chemical Abstracts, Inspec, SciSearch, STN International

INTRODUCTION

Investigations in the area of nanoscience and nanotechnology (NNT) are at present related to the priority research all over the world [1, 2]. They are developing swiftly, so almost continuous information monitoring is necessary to evaluate their state, structure, dynamics, trends and outlooks. The tools for such an observation are submitted in particular by bibliometrics dealing with the statistics of scientific publications (including patents) and their citing. The amount of bibliometric studies concerning NNT is sharply increasing in Russia (for example, see [3–13]) and abroad. The number of these works approaches hundred and their analysis requires a special review, which falls out of the scope of the present article. Bibliometric examination of NNT is carried out mainly relying on the databases (DB) of Science Citation Index (SCI) and a number of patent DB (for example, USPTO, EPO and WIPO) [2, 3, 13–19]). In general, bibliometric monitoring of NNT revealed the exponential development of the area starting from 1990-es [14–17] and its immanently interdisciplinary character. The majority of publications are connected with physics, chemistry and materials science.

The results of bibliometric examination are to a large extent dependent on the sources of primary bibliometric information involved and on the criteria for choosing the relevant publications. In the case of NNT, the major problem is to achieve the maximal possible completeness of initial information. Separate use of either polythematic or specialized DB does not provide such completeness: in the former case due to comparatively limited number of abstracted sources, and in the latter case due to the interdisciplinary character of the area. One of the solutions of this problem is the combined use of polythematic and specialized DB.

In the present work, home studies and developments in the area of NNT are examined with the help of the joint use of SCISearch database (SCI version), Chemical Abstracts (CA) and Inspec DB of the informational Scientific and Technical Network (STN) International [20]. The first of them, SCISearch database [21], is a multidisciplinary one, while CA DB [22] and Inspec DB [23] embrace chemical and physical sciences, respectively, as well as a number of adjacent areas including materials science. The combined use of three DB incorporated into the global information network with unified search and analytical tools allows one to take into account the interdisciplinary character of NNT, to provide the necessary completeness of the coverage of sources, and to carry out day-to-day statistical processing of large information arrays. Such an approach has been already used several times for bibliometric studies of chemical sciences in Russia [24–26].

RESULTS AND DISCUSSION

At first, here we will consider in brief the results of preceding bibliometric works on NNT in Russia and abroad. Bibliometric analysis provides evidence that the leading positions in this area are occupied by the USA, Japan and Germany [14–17]. At the boundary of the centuries, Russia occupied the 7th place in the world having produced in 1997–1999 4.6 % of the world documentation flow in the area under discussion, while the USA accounted for 23.7 %, Japan 12.5 %, Germany 10.7 %. The most substantial Russian organization was RAS with which a half of all the Russian publications on NNT was connected in 1986–1995 [14–17]. In this situation, according to Essential Science Indicators DB, during the years 1991–2000 RAS with 813 publications and the average citation index of 2.47 occupied the 22nd place among 25 organizations most frequently cited in the area of NNT [27, 28].

The reasons of such a situation with NNT in Russia are not quite clear. In general, to get a true understanding, expert judgments are necessary (see, for example, [1]), along with bibliometric indices, and a combination of both approaches. Previously, Russian investigations in the area of NNT were analyzed by means of bibliometry over the RFBR DB and the database of the Patents of Russia (PR) [4, 5]. During the years 1993–2001, RFBR supported

TABLE 1

Controllable terms from CA DB with prefix *nano* matched with domestic publications on NNT

Term	Number of publications
nanoparticles	1945
nanostructures	1387
nanotubes	1022
nanocomposites	725
nanocrystals	696
nanocrystalline metals	422
nanocrystalline materials	260
nanowires	123
semiconductor nanostructures	105
nanotechnology	92
nanofibers	77
nanostructured materials	73
pharmaceutical nanoparticles	32
pharmaceutical nanocapsules	2
nanoporous materials	24
nanocrystallization	22
nanomachines	20
nanospheres	18
nanodevices	12
nanocrystallites	13
nanowires (metallic)	10
nanoscale semiconductor devices	7
nanofabrication	4
nanoelectromechanical systems	2
nanoemulsions	1
nanosensors	2
nanocapsules	1
nanodisks	1
nanodots	1

TABLE 2

Controllable terms from Inspec DB matched with domestic publications on NNT

Term	Number of publications
nanostructured materials	3046
nanoparticles	928
nanotechnology	638
carbon nanotubes	469
nanocomposites	356
nanoporous materials	100
nanowires	96
nanotubes	90
nanoelectronics	65
nanolithography	59
nanobiotechnology	38
nanotube devices	19
semiconductor nanotubes	16
nanocontacts	12
nanopatterning	6
nanophotonics	4
nanopositioning	4
nanofabrication	1
nanofibres	1
nanofiltration	1

TABLE 3

Classification codes of Inspec DB with prefix *nano* matched with domestic publication on NNT

Code	Title	Number of publications
A6146	Structure of solid clusters, nanoparticles, and nanostructured materials	1667
	Structure of solid clusters, nanoparticles, nanotubes and nanostructured materials	1180
A7550k	Amorphous and nanostructured magnetic materials	736
A8116	Methods of nanofabrication and processing	495
B2550n	Nanometre-scale semiconductor fabrication technology	211
A7125w	Electronic structure of solid clusters and nanoparticles	188
B0587	Fullerenes, carbon nanotubes, and related materials (engineering materials science)	82
B2230f	Fullerene, nanotube and related devices	61
A8783	Nanotechnology applications in biomedicine	57
A8116d	Self-assembly in nanofabrication	50
A8 116n	Nanolithography	29
E1520p	Nanofabrication	18
E3644t	Nanotechnology industry	13
A8116r	Nanopatterning	11
B7230m	Microsensors and nanosensors	10
A4284	Nanophotonic devices and technology	4
B4146	Nanophotonic devices and technology	3
A0710c	Micromechanical and nanomechanical devices and systems	1
A8116t	Nanopositioning and atom manipulation	1

425 unsolicited research projects containing the prefix *nano* in their titles. For the same period, only 25 patents and 31 claims containing this prefix in titles were found in the PR database [4, 5]. It follows from these data that fundamental research dominates over the development of technologies. The distribution of RFBR projects over the research areas provides evidence of the prevalence of physical (55.8 %) and chemical (41.7 %) investigations and almost complete absence of biomedical investigations (0.2 %). The major subjects of investigation were nanostructures (25.9 %), nanoparticles (13.8 %)

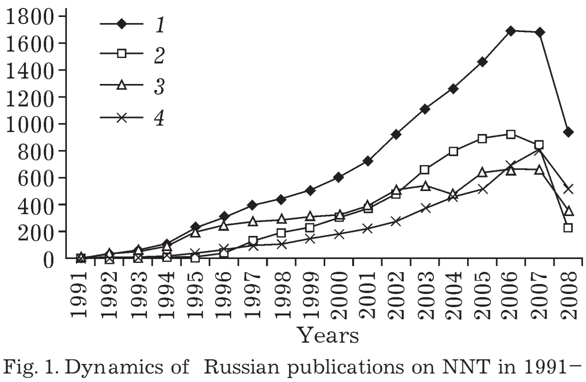

Fig. 1. Dynamics of Russian publications on NNT in 1991–2007 (data for 2008 are limited by the date of search): *1* – total number of publications, *2–4* – number of publications in CA, Inspec and SCISearch DB, respectively

TABLE 4

Distribution of Russian publications on NNT over kinds

Kind	Number of documents, (%)		
	SCISearch DB	CA DB	Inspec DB
Journal	4505 (100)	5389 (88.74)	5396 (90.05)
Article	4286 (95.14)	–	–
Conference	2 (0.04)	279 (4.59)	1990 (33.21)
Patent	–	293 (4.82)	–
General review	181 (4.02)	602 (9.91)	134 (2.24)
Book	–	13 (0.21)	1 (0.02)
Preprint	–	99 (1.63)	–
Online computer file	–	39 (0.64)	–
Computer optical disk	–	25 (0.41)	–
Editorial	12 (0.27)	–	–
Errata	1 (0.02)	–	–
Letter	20 (0.44)	–	–
Note	3 (0.07)	–	–
Theoretical	–	–	1790 (29.87)
Experimental	–	–	4372 (72.96)
Conference article	–	–	1990 (33.21)
Translation abstracted	–	–	1893 (31.59)
Practical	–	–	516 (8.61)
Application	–	–	73 (1.22)
Bibliography	–	–	56 (0.93)
New development	–	–	23 (0.38)
Original abstracted	–	–	9 (0.15)
Economic aspects	–	–	4 (0.07)
Book article	–	–	1 (0.02)
Product review	–	–	1 (0.02)

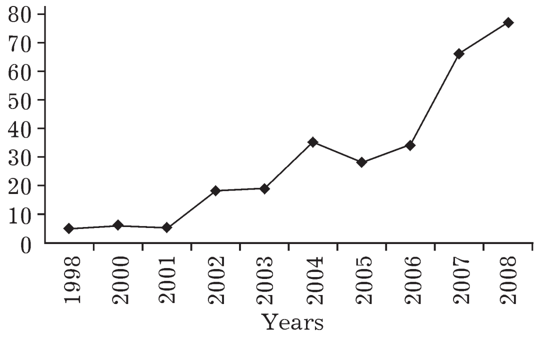

Fig. 2. Dynamics of patents with Russian authors in the area of NNT (CA DB).

and nanotubes (10.3 %). The projects were carried out in 98 organizations, mainly RAS institutions (65.3 %) and MES RF (19.4 %) in the European part of the country. RAS projects were concentrated in Moscow and the Moscow Region (46.8 %) and in St, Petersburg (20.4 %); the Siberian, Ural and Far East branches accounted for only 19.7, 4.6 and 0.7 % of works, respectively. Among the institutions of MES, Moscow and Moscow Region dominated (62.8 %), and St. Petersburg (16.3 %). The leadership in the number of implemented and current RFBR projects belonged to Ioffe Physical and Technical Institute, RAS (St. Petersburg, 51 project), Lomonosov MSU (Moscow, 43) and Rzhanov Institute of Semiconductor Physics, SB RAS (Novosibirsk, 19) [4, 5]. It is necessary to stress that the high concentration of investigations in the priority directions of science in separate scientific centres and in relatively small number of organizations is typical for Russia [13].

Along with this, the considered interesting and important results are likely to provide an

TABLE 5

Russian organizations that are the most productive in the area of NNT

Organizations*	City	Type**	Number of publications			
			CA DB	Inspec DB	SCISearch DB	
					without reprint	with reprint
Moscow MV Lomonosov State Univ	Moscow	1	548	513	406	290
Ioffe Phys Tech Inst	St. Petersburg	2	324	528	355	187
Inst Semicond Phys	Novosibirsk	2	145	200	113	124
Prokhorov Inst Gen Phys	Moscow	2	149	190	180	78
Inst Phys Met	Yekaterinburg	2	143	182	86	71
Russia			176			
Boreskov Inst Catalysis	Novosibirsk	2	146	56	170	91
Ufa State Aviat Technol Univ (Inst Phys Adv Mater)	Ufa	1	95	87	149	71
Inst Problems Chem Phys	Chernogolovka	2	115	70	75	83
Inst Solid State Phys	Chernogolovka	2	79	108	48	38
St. Petersburg State Univ	St. Petersburg	1	107	42	108	65
Moscow State Inst Steel Alloys	Moscow	1	107	82	72	51
Semenov Inst Chem Phys	Moscow	2	107	52	75	41
Nikolaev Inst Inorg Chem	Novosibirsk	1	104	76	67	70
Frumkin Inst Phys Chem Electrochem	Moscow	2	97	15	96	59
Nesmeyanov Inst Organoelement Cpds	Moscow	2	47	19	91	25
Kurnakov Gen Inorgan Chem Inst	Moscow	2	80	45	90	54
Vavilov State Opt Inst	St. Petersburg		64	89	49	31
Lebedev Phys Inst	Moscow	2	63	73	88	41
Inst Radio Eng & Electron	Moscow	2	45	86	48	19
Shubnikov Crystallog Inst	Moscow	2	62	63	81	27
Inst Problems Mech Engn	St. Petersburg	2	63	74	76	70
Kirenski Inst Phys	Krasnoyarsk	2	73	72	16	20
Inst Met Superplast Problems	Ufa	2	46	68	70	31

*Titles are presented as used in the DB. For 178 publications in DB, Russia is indicated as the address.

**1 – university; 2 – institute of RAS.

TABLE 6

Geographic distribution of domestic publications on NNT

Cities*	Number of publications			
	CA DB	Inspec DB	SCISearch DB	
			without reprint	with reprint
Moscow	2199	1991	1981	1060
St. Petersburg	909	1178	891	500
Novosibirsk	573	538	543	376
Yekaterinburg	344	407	232	207
Chernogolovka	255	257	167	147
Tomsk	167	139	105	66
Ufa	159	174	240	110
Krasnoyarsk	123	101	54	33
Nizhny Novgorod	112	141	105	53
Izhevsk	110	96	32	38
Troitsk	89	142	71	40
Saratov	86	123	78	47
Not indicated	104			
Russia	176			

*City is not indicated in the CA DB for 104 publications, Russia is indicated as the address for 176 publications.

TABLE 7

Distribution of domestic patents in 2005–2008 in the area of NNT over organizations (CA DB)

Number of patents	Organization*	Department
50	Russia	
9	Institut Fiziki Tverdogo Tela RAN	RAS
5	Boreskova Institut Kataliza Sibirskogo Otdeleniya RAN	RAS
5	Karpov Institute of Physical Chemistry	FSUE
4	Institut Prikladnoi Mekhaniki URO RAN	RAS
4	Vserossiiskii Nauchno-Issledovatelskii Institut Aviatsionnykh Materialov (VIAM)	FSUE

*Only the most productive organizations are indicated; titles are presented according to DB records.

TABLE 8

Sources in which domestic publications in the area of NNT appeared most frequently (>100 times) (domestic issues and their translated versions are italicized)

Sources	Number of publications			
	Non-identical	CA DB	Inspec DB	SCISearch DB
Fiz. Tverd. Tela (S.-Peterburg)/Phys. Solid State	510	243	340	125
Proc. SPIE – Int. Soc. Opt. Eng.	392	155	361	–
Fiz. Met. Metalloved./Phys. Met. Metallogr.	282	135	239	34
Pis'ma v Zh. Tech. Fiz./Tech. Phys. Lett.	272	128	189	37
Phys. Rev. B: Condensed Matter Mater. Phys.	260	79	110	148
Russ. Patents	258	258	–	–
Pis'ma v Zh. Eksp. i Teoret. Fiz./JETP Lett.	218	90	155	53
Fiz. Tech. Poluprovodnikov (Sankt-Peterburg)/Semiconductors	209	106	149	60
J. Magn. Magn. Mater	190	74	145	81
Inorg. Mater.	180	110	138	45
Izv. Akad. Nauk, Ser. Fiz./Bull. Russ. Acad. Sci., Phys.	176	94	110	6
Mater. Sci. Eng. A – Struct. Mater. Prop. Microstruct. Process	172	32	42	158
Fiz. Khim. Stekla/Glass Phys. Chem.	129	92	95	20
Zh. Tekh. Fiz./Tech. Phys.	128	55	88	24
Mater. Sci. Forum	124	57	97	12
Zh. Eksp. Teor. Fiz./J. Exp. Theor. Phys.	124	63	77	37
Physica E – Low-Dimensional Systems and Nanostructures	113	18	25	103

TABLE 9

Thematic topics in CA DB to which domestic publications on NNT were related most frequently in 2005–2008

Topics	Number of publications, %
73 – Optical, electron, and mass spectroscopy and other related properties	416 (14.41)
76 – Electric phenomena	321 (11.12)
57 – Ceramics	300 (10.40)
56 – Nonferrous metals and alloys	236 (8.18)
66 – Surface chemistry and colloids	203 (7.03)
77 – Magnetic phenomena	199 (6.90)
65 – General physical chemistry	160 (5.54)
75 – Crystallography and liquid crystals	115 (3.98)
37 – Plastics manufacture and processing	88 (3.05)
67 – Catalysis, reaction kinetics, and inorganic reaction mechanisms	67 (2.32)
55 – Ferrous metals and alloys	65 (2.25)
49 – Industrial inorganic chemicals	58 (2.01)

TABLE 10

Controllable terms in CA DB and Inspec DB without prefix *nano* most frequently matched with domestic publications on NNT

Term	Number of publications, %
CA DB	
microstructure	401 (6.60)
particle size	346 (5.70)
clusters	324 (5.34)
luminescence	280 (4.61)
annealing	284 (4.68)
powders	254 (4.18)
surface structure	269 (4.43)
plastic deformation	246 (4.05)
simulation and modeling	243 (4.00)
vapor deposition process	222 (3.66)
grain size	225 (3.70)
electric conductivity	208 (3.42)
magnetization	205 (3.38)
UV and visible spectra	190 (3.13)
ceramics	179 (2.95)
films	175 (2.88)
crystal structure	153 (2.52)
Raman spectra	152 (2.50)
Inspec DB	
X-ray diffraction	514 (8.58)
elemental semiconductors	511 (8.53)
transmission electron microscopy	501 (8.36)
silicon	498 (8.31)
iron alloys	444 (7.41)
annealing	425 (7.09)
ferromagnetic materials	387 (6.46)
photoluminescence	372 (6.21)
fullerenes	364 (6.07)
silicon compounds	351 (5.86)
grain size	328 (5.47)
amorphous magnetic materials	305 (5.09)

incomplete description of the Russian situation with NNT due to the limited initial informational basis. A natural method to broaden the latter is to use modern DB providing both the maximal embracement of the area of interest and its detalization down to the level of specific researchers).

In the present work, search for Russian publications in NNT was carried out in SCISearch and CA databases in September 2008; in Inspec DB in February 2009. Fir identification, we used the presence of Russia in the address of at least one authors and indexes terms of DB containing prefix *nano*: in CA DB in the index Controlled Terms (Table 2), in Inspec DB in the indexes of controlled terms (Table 2) and in Classification Codes (Table 3), in SCISearch DB in the indices of Supplementary Terms and Supplementary Terms Plus. In the latter case, also the code *nanoscience* and *nanotechnology* in the index of Classification Codes was also taken into account. The terms non-relevant for NNT, such as nanosecond, nanoampere and so on, as well as chemical formulas $NaNO_2$, $NaNO_3$ were excluded.

The total number of Russian publications on NNT during the period of 1991–2008 found in databases was: SCISearch 4505, CA – 6073, Inspec – 5992. After the elimination of duplicates, the generalized set over three DB was 12455 non-identical publications (Fig. 1). A small number of duplicates provide evidence that in the case of Russian investigations in the area of NNT, SCISearch, CA and Inspec databases

TABLE 11

Classification codes of SCISearch DB most frequently matched with domestic publications on NNT

Code	Number of publications, %
Materials science, multidisciplinary	1352 (30.01)
Physics, condensed matter	1060 (23.53)
Chemistry, physical	768 (17.05)
Physics, applied	729 (16.18)
Nanoscience and nanotechnology	557 (12.36)
Physics, atomic, molecular and chemical	276 (6.13)
Chemistry, multidisciplinary	245 (5.44)
Optics	230 (5.11)
Metallurgy and metallurgical engineering	212 (4.71)
Physics, multidisciplinary	212 (4.71)
Engineering, electrical, and electronic	184 (4.08)
Instruments and instrumentation	162 (3.60)
Nuclear science and technology	127 (2.82)
Materials science, coating and films	123 (2.73)
Polymer science	110 (2.44)
Chemistry, inorganic and nuclear	108 (2.40)

cardinally complement each other thus promoting our approach to the objective picture. It is noteworthy that among 12455 non-identical publications only 3301 (26.5 %) were found in all the three databases or in any two of them, 31098 publications – only in CA DB, 3261 – only in Inspec DB and 2695 – only in SCISearch DB. It is important that the databases supplement each other not only in the subjects but also functionally. The CA and Inspec databases indicate only the address of the first author of publication, so the works with the participation of Russian scientists but with the first author from another country were not revealed in search over these databases. Unlike for this situation, the SCISearch DB lists the addresses of all the authors.

The dynamics of Russian publications on NNT is presented in Fig. 1; their distribution over kinds is shown in Table 4. One can see that jour-

TABLE 12

Additional terms in SCISearch DB most frequently matched with domestic publications in NNT

Term	Number of publications, %	Term	Number of publications, %
Terms ST* containing prefix *nano* (occurring more than 50 times):		Terms STP** containing prefix *nano* (occurring more than 50 times):	
nanostructure(s)	236 (5.24)	nanoparticles	317 (7.04)
nanoparticles	227 (5.04)	nanotubes	214 (4.75)
carbon nanotubes	100 (2.22)	nanostructures	168 (3.73)
nanocrystals	71 (1.58)	carbon nanotubes	163 (3.62)
nanocomposites	54 (1.20)	nanocrystals	159 (3.53)
nanotubes	52 (1.15)	nanocrystalline materials	72 (1.60)
		nanocomposites	60 (1.33)
		nanoclusters	54 (1.20)
		nanocrystalline	53 (1.18)
Термины ST*, containing no prefix *nano* (occurring more than 30 times):		Термины STP**, containing no prefix *nano* (occurring more than 100 times):	
severe plastic deformation	69 (1.53)	films	220 (4.88)
silicon	51 (1.13)	growth	205 (4.55)
photoluminescence	47 (1.04)	particles	179 (3.97)
ion implantation	45 (1.00)	surface	142 (3.15)
microstructure	45 (1.00)	thin films	120 (2.66)
X-ray diffraction	43 (0.95)	size	117 (2.60)
mechanical properties	37 (0.82)	behavior	114 (2.53)
structure	37 (0.82)	spectroscopy	114 (2.53)
quantum dots	34 (0.75)	optical properties	109 (2.42)
field emission	31 (0.69)	severe plastic deformation	108 (2.40)
luminescence	31 (0.69)	clusters	100 (2.22)

* Supplementary Terms.

** Supplementary Terms Plus.

nal publications – articles and reviews – dominate in all the databases. Attention should be paid to the large number of abstracts of conference reports listed in Inspec DB.

The fraction of patents taken into account only in CA DB after recalculation for the total number of non-identical publications is only 2.35 %. If this number is used to evaluate the innovation potential of research, this potential can be considered not high. An encouraging trend, however, is a noticeable increase in the number of patents per year (Fig. 2). Among 203 patents, 258 (88.05 %) are Russian, 13 – USA, and 22 – claims (WIPO).

Institutions that are most productive in the area of NNT are listed in Table 5 (the term "reprint" in SCISearch DB points to the "leading author" of publication and, in this context, leading organization). One can see that the leader is MSU, but in general the institutions of RAS dominate, including SB RAS.

The geographic distribution of home publications on NNT is presented in Table 6. The most noticeable cities are Moscow, St. Petersburg and Novosibirsk. The prevalence of publications containing no "reprint" term in SCISearch DB in all the cases except Izhevsk points to the fact that the corresponding part of the "leading authors" works in foreign organizations.

The distribution of home patents of the years 2005–2008 in the area of NNT over organizations is shown in Table 7. It should be noted that 50 patents (22.42 % of the total number) are related simply to Russia. In the cases when the departmental affiliation could be established, 56 rate to RAS, 33 to MES, while the organizations named federal state unitary enterprises, limited liability companies; closed companies and so on hold 84 patents.

The sources in which Russian publications on NNT appeared most frequently include a large number of leading international and home journals (Table 8). So, the results obtained by Russian researchers are quite well available for the international professional community. Attention is to be paid tot eh fact that home chemical and materials science journals are almost completely absent from Table 8. It should be kept in mind also that specialized Russian issues, for example "Russian Nanotechnologies", have been founded only recently.

TABLE 13

International cooperation of scientists in the area of NNT (more than 100 joint publications) according to SCISearch DB

Country	Number of joint publications	
	without reprint term	with reprint term
Germany	704	279
the USA	544	203
France	392	146
Japan	267	110
Italy	175	45
England	148	67
Spain	112	35
Poland	102	36

Special interest is attracted to thematic headers, controlled terms and classification codes over which the publications under discussion have been indexes in DB, because they allow one (though approximately) to characterize the subjects of publications (see Tables 2, 3, 9–12). The topics in CA DB (see Table 9) do not provide direct reflection of the subjects of nanoscience, but instead they stress the broad diversity of objects, phenomena and methods of investigations connected with NNT in one or another manner, and the interdisciplinary character of the area in general. In this connection, controlled terms are more useful (Table 2), especially those containing prefix *nano*, among which nanoparticles is the dominating term. In CA DB, Russian publications on NNT are matched with many controllable terms containing no this prefix (see Table 10). A similar situation is observed also for Inspec DB (compare Tables 3 and 10).

Classification codes (see Table 11) and additional terms (see Table 12) from SCISearch DB, most frequently matching with the Russian publications on NNT, also depict first of all the multidisciplinary character of the area. The code Nanosciences and Nanotechnology was related to only 12.36 % of works (see Table 11). This can be connected with the fact that the code was introduced in the DB relatively recently. On the basis of overall codes, 50.55 % of publications were related to physics, 32.74 % to materials science, 24.89 % to chemistry.

In general, over all DB, one can see that the home works on NNT are mainly connected with the problems of physics, materials science and chemistry. Attention should be paid to the insignificant number of codes related to biomedicine, in particular pharmaceuticals. This agrees with the results of the bibliometric analysis of the document and information flow on nanobiotechnologies based on Scopus DB, which showed that investigations in this area have not yet received the due development in Russia in comparison with other countries [29]. To reveal the actual situation completely, it is likely that additional search in specialized DB of STN, for example DB Medicine and DB Biosis is to be carried out.

In SCISearch DB, the term “reprint” means the so-called leading author of a publication. To evaluate the role of home scientists in NNT research carried out under the conditions of international cooperation, a comparative analysis of the number of publications matched with our country and containing the term “reprint” (providing evidence that the leading author of a publication works in Russia) and the total number of publications was carried out. With respect to this index, except for the cases of the Institute of Semiconductor Physics SB RAS, and the Institute of the Problems of Chemical Physics RAS, the leading role is played by foreign partners among whom the scientists from Germany, USA and France dominate (Table 13).

The search for publications citing home works on NNT was carried out in May 2009 in SCISearch DB (retrospective review of citing down to 1996). By that moment, CA and Inspec databases contained 14 040 non-identical Russian works (compare with the data presented above). This set was not analyzed in detail, but it was only used to study citation. The number of citations found in SCISearch DB was 56 969, in CA DB 54 217. As a total, about 52 % of publications were cited – more than 7350 articles, patents and abstracts of conference reports. The highest citation was recorded for articles in journals: about 7200 articles were cited according to CA and SCISearch DB 53 594 and 56 335 times, respectively. About 2570 publications in approximately 120 Russian journals received 9189 and 9918 citations in CA and SCISearch DB, respectively. The dynamics of publications and their citing is represented in

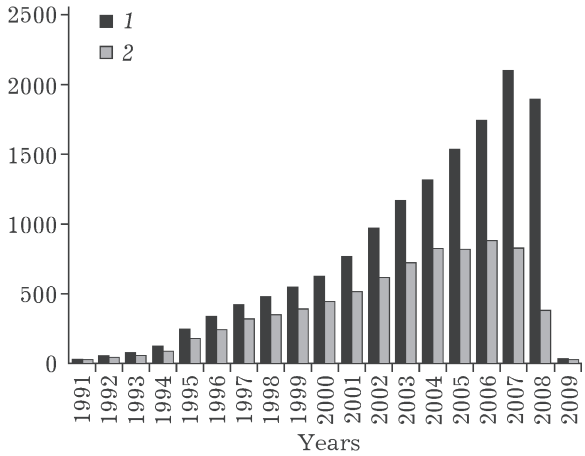

Fig. 3. Dynamics of domestic publications on NNT and their citing for 1991–2007 (data for 2008 are limited by the date of search): *1* – total number of publications; *2* – number of cited publications.

Fig. 3. As far as one may consider, during the recent time an increase in the number of citations exceeds an increase in the number of publications. However, conclusions concerning the stability of this trend would be untimely. Russian publications in the area of NNT having been cited 150 times and more are listed in Table 14. One can see that the total number of publications (21) includes 13 articles, seven reviews and one note. In this situation, in 11 publications a foreign address of the leading author is given. Attention should be paid to the fact that works Nos. 19 and 21 are connected with biomedicine and pharmaceutics, respectively. The issues that received the largest number of citing in connection with Russian publications in the area of NNT (more than 500 references) are listed in Table 15.

CONCLUSION

The interdisciplinary character of investigations and developments in the area of NNT puts forward specific demands to the procedures of collecting the initial information for bibliometric analysis. The application of any one DB, even such as SCI, can be insufficient, in the case of Russian science also because it is represented in global English-language DB incompletely.

Using three DB of the STN International (SCISearch, CA and Inspec), only 26.5 % (that is, less than one third) of non-identical domes-

TABLE 14

Russian publications in the area of NNT cited more than 100 times

Publications	Address of the first author	Number of citations	
		CA DB	SCISearch
1. Novoselov KS, Geim AK, Morozov SV, Jiang D, Zhang Y, Dubonos SV, Grigorieva IV, Firsov AA. Electric field effect in atomically thin carbon films // Science. 2004. Vol. 306. N 5296. P. 666-669. Document type: article	Dept. Phys., Manchester Univ., UK	1645	1279
2. Valiev RZ, Islamgaliev RK, Alexandrov IV. Bulk nanostructured materials from severe plastic deformation // Progress in Materials Science. 2000. Vol. 45. N 2. P. 103-18. Document type: review	Inst. Phys. Adv. Mater., Ufa State Aviation Tech. Univ., Russia	1543	1353
3. Donath E, Sukhorukov GB, Caruso F, Davis SA, Mohwald H. Novel hollow polymer shells by colloid-templated assembly of polyelectrolytes // Angewandte Chemie International Edition. 1998. Vol. 37. N 16. P. 2202-2205. Document type: article	Max-Planck-Institute Colloids Interfaces, Berlin, Germany	459	454
4. Novoselov KS, Jiang D, Schedin F, Booth TJ, Khotkevich VV, Morozov SV, Geim AK. Two-dimensional atomic crystals // Proceedings of the National Academy of Sciences of the United States of America. 2005. Vol. 102. N 30. P. 10451-10453 Document type: article	Sch. of Phys. Astron., Manchester Univ., UK	474	362
5. Shchukin VA, Ledentsov NN, Kopev PS, Bimberg D. Spontaneous ordering of arrays of coherent strained islands // Physical Review Letters. 1995. Vol. 75. N 16. P. 2968-2971. Document type: article	A.F. Ioffe Physicotech. Inst., Acad. Sci., St. Petersburg, Russia	416	385
6. Valiev RZ, Kozlov EV, Ivanov YF, Lian J, Nazarov AA, Baudelet B. Deformation behavior of ultra-fine-grained copper // Acta Metallurgica et Materialia. 1994. Vol. 42. N 7. P. 2467-2475. Document type: article	Genie Phys. Mecanique Mater., Inst. Nat. Polytech. Grenoble, France	280	303
7. Valiev RZ, Langdon TG. Principles of equal-channel angular pressing as a processing tool for grain refinement // Progress in Materials Science. 2006. Vol. 51. N 7. P. 881-981. Document type: review	Inst. Physics Adv. Mater., Ufa State Aviation Tech. Univ., Ufa, Russia	247	228
8. Mirebeau I, Hennion M, Casalta H, Andres H, Gudel HU, Irodova AV, Caneschi A. Low-energy magnetic excitations of the Mn-12-Acetate spin cluster observed by neutron scattering // Physical Review Letters. 1999. Vol. 83. N 3. P. 628-631. Document type: article	CEA, Centre d'Etudes Nucleaires de Saclay, Gif-Sur-Yvette, France	217	141
9. Ledentsov NN, Ustinov VM, Shchukin VA, Kop'ev PS, Alferov ZI, Bimberg D. Quantum dot heterostructures: Fabrication, properties, lasers // Semiconductors. 1998. Vol. 32. N 4. P. 343-365. Document type: review	A.F. Ioffe Physicotech. Inst., Acad. Sci., St. Petersburg, Russia	205	196
10. Prokof'ev NV, Stamp PCE. Theory of the spin bath // Reports on Progress in Physics. 2000. Vol. 63. N 4. P. 669-726. Document type: review	Sci. Centre, Kurchatov Inst., Moscow, Russia	187	165
11. Krainov VP, Smirnov MB. Cluster beams in the super-intense femtosecond laser pulse // Physics Reports-Review Section of Physics Letters. 2002. Vol. 370. N 3. P. 237-331. Document type: review	Moscow Inst. Phys. Technol., Dolgoprudnyi, Russia	180	176
12. Grigorenko AN, Geim AK, Gleeson HF, Zhang Y, Firsov AA, Khrushchev IY, Petrovic J. Nanofabricated media with negative permeability at visible frequencies // Nature. 2005. Vol. 438. N 7066. P. 335-338. Document type: article	Dept. Phys. Astron., Manchester Univ., UK	147	177

TABLE 14 (End)

Publications	Address of the first author	Number of citations	
		CA DB	SCISearch
13. Valiev R. Nanostructuring of metals by severe plastic deformation for advanced properties // Nature Materials. 2004. Vol. 3. N 8. P. 511-516. Document type: review	Inst. Phys. Adv. Mater., Ufa State Aviation Tech. Univ., Russia	174	154
14. Prinz VY, Seleznev VA, Gutakovsky AK, Preobrazhenskii VV, Putyato MA, Gavrilova TA. Free-standing and overgrown InGaAs/GaAs nanotubes, nanohelices and their arrays // Physica E. 2000. Vol. 6. N 1-4. P. 828-831. Document type: article	Inst. of Semicond. Phys., Acad. Sci., Novosibirsk, Russia	126	169
15. Blank VD, Buga SG, Dubitsky GA, Serebryanaya NR, Popov MY, Sundqvist B. High-pressure polymerized phases of C-60 // Carbon. 1998. Vol. 36. N 4. P. 319-343. Document type: review	Res. Center for Superhard Mater., Troitsk, Russia	166	139
16. Schedin F, Geim AK, Morozov SV, Hill EW, Blake P, Katsnelson MI, Novoselov KS. Detection of individual gas molecules adsorbed on graphene // Nature Materials. 2007. Vol. 6. N 9. P. 652-655. Document type: article	Univ. of Manchester, Manchester, UK	163	153
17. Meltzer RS, Feofilov SP, Tissue B, Yuan HB. Dependence of fluorescence lifetimes of Y2O3 : Eu3+ nanoparticles on the surrounding medium // Physical Review B. 1999. Vol. 60. N 20. P. R14012-R14015 Document type: article	Georgia Univ., Athens, GA USA	157	124
18. Rebohle L, Vonborany J, Yankov RA, Skorupa W, Tyschenko IE, Frob H, Leo K. Strong blue and violet photoluminescence and electroluminescence from germanium-implanted and silicon-implanted silicon dioxide layers // Applied Physics Letters. 1997. Vol. 71. N 19. P. 2809-2811. Document type: article	Inst. Ionenstrahlphys. Materforsch., Forschungszentrum Rossendorf E.V., Dresden, Germany	155	128
19. Kreuter J, Alyautdin RN, Kharkevich DA, Ivanov AA. Passage of peptides through the blood-brain-barrier with colloidal polymer particles (nanoparticles) // Brain Research. 1995. Vol. 674. N 1. P. 171-174. Document type: note	Inst. Pharm. Technol., J. W. Goethe-Univ., Frankfurt am Main, Germany	154	139
20. Furukawa M, Horita Z, Nemoto M, Valiev RZ, Langdon TG. Microhardness measurements and the Hall-Petch relationship in an Al-Mg alloy with submicrometer grain size // Acta Materialia. 1996. Vol. 44. N 11. P. 4619-4629. Document type: article	Dept. Mater. Sci. Eng., Kyushu Univ., Fukuoka, Japan	151	142
21. Gulyaev AE, Gelperina SE, Skidan IN, Antropov AS, Kivman GY, Kreuter J. Significant transport of doxorubicin into the brain with polysorbate 80-coated nanoparticles // Pharmaceutical Research. 1999. Vol. 16. N 10. P. 1564-1569. Document type: article	Karaganda Med. Acad., Karaganda, Kazakhstan	150	131

tic publications on NNT were found in any or any two of them. This circumstance must be taken into account in further bibliometric studies in the area of NT.

According to the obtained bibliometric data, the internal dynamics of domestic research in the area of NNT is positive: since approximately 2000 a steady growth is observed, which corresponds to the general world trend.

In the terms of traditional disciplines the works are connected mainly with physics, materials science and chemistry. The number of works related to biomedicine, in particular to pharmaceuticals, is insignificant.

TABLE 15

Most cited (more than 500 times) Russian publications on NNT (italicized are domestic issues and their translated versions)

Issues	Number of references		Number of cited publications
	CA DB	SCISearch DB	
Phys. Rev. B	3434	3068	235
Prog. Mater. Sci.	1866	1703	4
Phys. Rev. Lett.	1698	1373	41
Science	1648	1284	2
Fiz. Tverd. Tela (S.-Peterburg)/Phys. Solid State	1582	1614	382
Mater. Sci. Eng. A	555	1374	114
Appl. Phys. Lett.	1257	1169	77
Carbon	1115	1115	56
Pis'ma v Zh. Eksp. i Teor. Fiz./JETP Lett.	1009	933	163
J. Magn. Magn. Mater.	681	950	132
Fiz. Tech. Poluprovodnikov (Sankt-Peterburg)/Semiconductors	944	921	158
Usp. Khim./Russ. Chem. Rev.	825	788	54
Chem. Phys. Lett.	758	809	48
Nanostruct. Mater.	799	763	73
Diam. Relat. Mater.	774	738	85
Scripta Mater.	753	768	53
Nucl. Instrum. Meth. B	613	731	78
Angew. Chem. Int. Ed.	724	721	11
Fiz. Met. Metalloved./Phys. Met. Metallogr.	376	695	172
Langmuir	673	552	29
Appl. Surf. Sci.	507	658	61
Phys. Lett. A	639	646	43
J. Phys. Chem. B	609	605	35
Usp. Fiz. Nauk/Phys. Usp.	600	584	52
J. Appl. Phys.	586	598	48
J. Phys. Condens. Matter	583	534	67
Acta Mater	489	556	20
Zh. Eksp. Teor. Fiz./J. Exp. Theor. Phys./JETP	533	538	102
Thin Solid Films	506	537	66
Proc. Natl. Acad. Sci. USA	513	404	2

The data obtained provide evidence of the high concentration of domestic research in the area of NNT in separate scientific centres and in relatively small number of organizations. The leading role belongs to RAS. Leaders are distinguished, both organizations and research groups noticeable at the world level during a long time. The works are carried out mainly in the European part of our country; to the east of the Urals only the scientists from Novosibirsk, Tomsk and Krasnoyarsk appear to be active in the area of NNT. It is noteworthy that these conclusions are qualitatively independent of the sources of the primary bibliographic information – databases of the STN International used in the present work or the DB of RFBR used previously [4, 5].

Scientific cooperation with foreign scientists who often act as the "leading authors" of publications has a great significance.

Altogether, the positive dynamics of investigations and especially their innovative potential are clearly insufficient for Russia to achieve leading positions in the world in the area of NNT. This dynamics should be supported by a complex of necessary measures formulated, for example, in [1].

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