Роль проектов по обмену персоналом в развитии научной лаборатории

(опыт реализации проектов TerACan, Cacomel, FAEMCAR, NAmiceMC, CANTOR)

П.П.Кужир

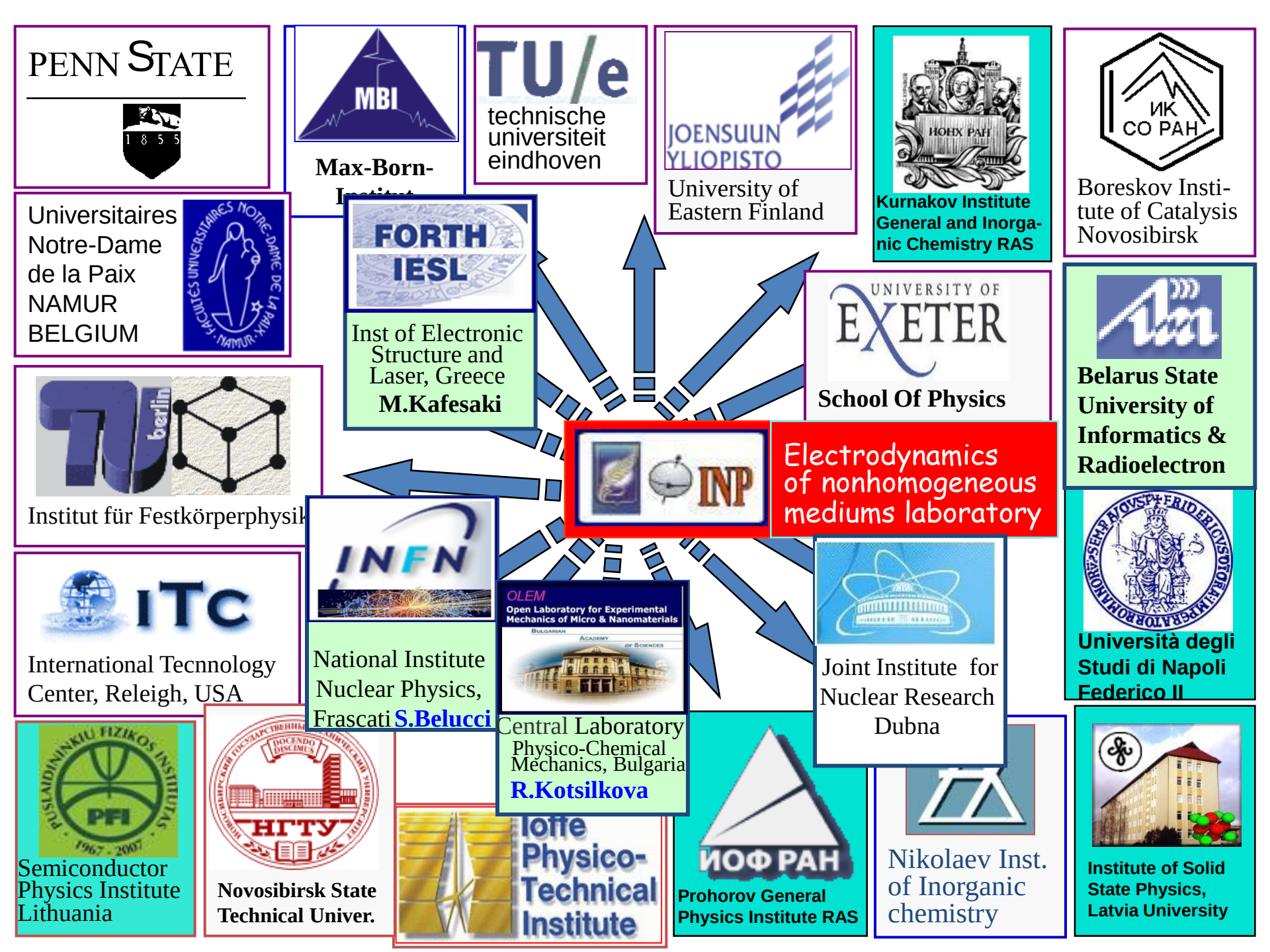
Институт ядерных проблем БГУ

Laboratory of electrodynamics of nonhomogeneous mediums

~ 20 persons

2 ScD (Research professors)
4 PhD
6 PhD students
3 MS students
Undergraduate students

8 INTAS projects
2 NATO SfP
2 NATO linkage
1 ISTC
5 EU FP-7 IRSES
1 EU FP-7 INCO
3 IB BMBF (Germany)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ИОНХ РАН
Kurnakov Institute
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tute of Catalysis
Novosibirsk
Universitaires
Notre-Dame
de la Paix
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BELGIUM
FACULTÉS UNIVERSITAIRES NOTRE-DAME DE LA PAIX · NAMUR ·
FORTH
IESL
Inst of Electronic
Structure and
Laser, Greece
M.Kafesaki
UNIVERSITY OF
EXETER
School Of Physics
Belarus State
University of
Informatics &
Radioelectron
berlin
Institut für Festkörperphysik
INP
Electrodynamics
of nonhomogeneous
mediums laboratory
INFN
ITC
International Tecnnology
Center, Releigh, USA
National Institute
Nuclear Physics,
Frascati S.Belucci
OLEM
Open Laboratory for Experimental
Mechanics of Micro & Nanomaterials
BULGARIAN
ACADEMY
OF SCIENCES
Central Laboratory
Physico-Chemical
Mechanics, Bulgaria
R.Kotsilkova
Joint Institute for
Nuclear Research
Dubna
Università degli
Studi di Napoli
Federico II
PUSLAIDININKIŲ FIZIKOS INSTITUTAS
PFI
1967 - 2007
Semiconductor
Physics Institute
Lithuania
DOCENDO
DISCIMUS
НГТУ
Novosibirsk State
Technical Univer.
Ioffe
Physico-
Technical
Institute
ИОФ РАН
Prohorov General
Physics Institute RAS
Nikolaev Inst.
of Inorganic
chemistry
Institute of Solid
State Physics,
Latvia University

Реализуемые и завершенные проекты IRSES

Terahertz applications of carbon-based nanostructures, EU FP7 TerACaN project FP7-230778, 2009-2013, Principal Researcher: M. Portnoi (Univer Exeter, UK), team leaders S. Maksimenko, O. Kibis (Novosibirsk, NSTU), I. Luk'yanchuk (Amiens University, France).

Nano carbon based components and materials for high frequency electronics, EU FP7 CACOMEL project FP7-247007, Call ID "FP7-PEOPLE-2009-IRSES", 2010-2014, Coordinator: Prof. Ch. Thomsen (Institut fuer Festkoerperphysik, TUB, Berlin, Germany), partners: S. Maksimenko, Y. Svirko (University of Joensuu,Finland), Yu.N. Shunin (University of Latvia, Institute of Solid State Physics). E. Obrazcova (A.M. Prokhorov General Physics Institute of RAS), P. Dyachkov (Kurnakov Institute of General and Inorganic Chemistry, RAS) G. Miano (Università degli Studi di Napoli Federico II, Italy)

Fundamental and Applied Electromagnetics of Nano-Carbons, EU FP7 project FP7- 318617 FAEMCAR, Call ID FP7-PEOPLE-2012-IRSES, 2012-2017, Principal Researcher: Ph. Lambin (Facultes Universitaires Notre-Dame de la paix de Namur, Belgium), team leaders: Y. Banis (Vilniaus Universitetas, Lithuania), S. Bellucci (Istituto Nazionale di Fisica Nucleare, Frascati, Italia), L. P. Biró (Research Centre for Natural Sciences, Hungarian Academy of Sciences, Budapest, Hungary), L.A. Chernozatonskii (Institute for Biochemical Physics RAS, Moscow, Russia), G. I. Dovbeshko (Institute of Physics, NASU, Kiev, Ukraine), P. Kuzhir (INP BSU).

Carbon-nanotube-based terahertz-to-optics rectenna, EU FP7 project FP7-612285 CANTOR, Call ID FP7-PEOPLE-2013-IRSES, 2013-2017, Principal Researcher: M. Portnoi (University of Exeter, UK), team leaders S. Maksimenko (INP BSU), G. Slepyan (Tel Aviv University, Israel)

Nano-Thin and Micro-Sized Carbons: Toward Electromagnetic Compatibility Application, project FP7-610875 NAMICEMC, Call ID FP7-PEOPLE-2013-IRSES, 2013-2017, Principal Researcher: A. Celzard (ENSTIB, Universite de Lorraine, Epinal, Franse), team leaders: S. Bellucci (Istituto Nazionale di Fisica Nucleare, Frascati, Italia), P. Kuzhir (INP BSU).

Nano carbon based components and materials for high frequency electronics, EU FP7 **CACOMEL** project FP7-247007, Call ID "FP7-PEOPLE-2009-IRSES", **2010-2014**

SEVENTH FRAMEWORK PROGRAMME
Marie Curie Actions
People
International Research Staff Exchange Scheme

Annex I - "Description of Work"

3. Project summary

A strong expansion of the frequency range towards terahertz and infrared is the major trend in the modern electronics and optoelectronics. It relies on the incorporation of modern nanotechnology that has already given the birth to nanoelectronics, a rapidly developing discipline focused on both the dramatic increase of the component integration level and decrease in a power consumption. Performance of nanoelectronic devices is strongly influenced by quantum effects that often even determine properties of nano-sized components. The project aims at understanding of fundamentals of the electromagnetic processes in nanocircuits, theoretical and experimental investigation of underlying mechanisms responsible for their fascinating properties, and development of physical basis for use of these properties in novel nanoelectronic devices. The project focuses on resolving the problem of implementation of CNTs into nanoelectronics, and fabrication of nonlinear devices in fibers and waveguides for signal processing, all-optical switching, etc. The project has the following main objectives:

- to reveal the effects of spatial irregularities in the performance of CNT-based components and nanocircuits;
- to develop EMC theory of the circuits with nano-sized components;
- to perform experimental and theoretical investigation of high frequency and nonlinear optical properties of nano-carbon materials as potential materials for electromagnetic shielding and optical application.

Linear and nonlinear electromagnetic effects in nano-carbon structures, such as onion-like carbon and both single- and multi-wall carbon nanotubes, will be studied. Detail consideration to the performance of nanocircuits based on carbon nanotubes and other nanocarbon materials will be carried out, and fundamentals of the EMC theory as applied to circuits with nano-sized components will be developed. The role of intertube tunnelling in the performance of CNT-based high-frequency circuits will be studied. the second- and third order nonlinear optical effects in CNTs and other sp^2 nanocarbons to reveal their performance in nonlinear optical devices will be investigated. Different aspects of the design of materials based on sp2-nanocarbons for photonics and optoelectronics will be considered and the study of electromagnetic response of novel nano-carbon based composites to microwaves, THz, IR and optical frequencies will be undertaken in order to clarify their possible use for electromagnetic coating/shielding for a wide spectrum of technological applications.

The proposed multi-disciplinary research joins in a complimentary way differently experienced teams: electromagnetic theory and nanoelectromagnetism, solid state physics and quantum chemistry, characterization and optical spectroscopy of nano-carbons and nano-carbon materials, and nano-carbon fabrication technology. The composition of the research consortium provides for both successful realization of the project objectives and intensive knowledge exchange between teams. The challenging project relies on the complementary expertise of the consortium teams and is based on the original approach combining electrodynamics of mesoscopic inhomogeneous media and quantum theory of electronic ensembles with reduced dimensionality.

Full Title: Nano-carbon based components and materials for high frequency electronics

Acronym: CACOMEL

Proposal Number: 247007

Scientific Panel: PHY: Physics

Grant Agreement Number:

Duration of the project: 48 months

2. List of partner organisations

Partner Number	Partner name	Partner short name	Country
1 coordinator (*beneficiary*)	Technische Universität Berlin, Institut für Festkörperphysik	TUB	Germany
2 beneficiary	University of Joensuu	UJOE	Finland
3 beneficiary	Università degli Studi di Napoli Federico II	UNF	Italy
4 beneficiary	University of Latvia, Institute of Solid State Physics	ISSP	Latvia
5 partner organisation	Belarus State University, Institute for Nuclear Problems	INP	Belarus
6 partner organisation	A.M. Prokhorov General Physics Institute of Russian Academy of Sciences	GPI	Russia
7 partner organisation	Kurnakov Institute of General and Inorganic Chemistry, Russian Academy of Sciences	IGIC	Russia

Fundamental and Applied Electromagnetics of Nano-Carbons, EU FP7 project FP7- 318617 **FAEMCAR**, Call ID FP7-PEOPLE-2012-IRSES, **2012-2016**

SEVENTH FRAMEWORK PROGRAMME
Marie Curie Actions
People
International Research Staff Exchange Scheme

Annex I - "Description of Work"

DESCRIPTION OF WORK

PART A

1. *Grant agreement* details

Full Title: Fundamental and Applied Electromagnetics of Nano-Carbons

Acronym: FAEMCAR

Proposal Number: 318617

Scientific Panel: Physics

Grant Agreement Number: PIRSES-GA-2012-

Duration of the project: 48 months

Project start date: October 1, 2012

2. List of participants (*beneficiaries* and *partner organisations*)

Participant Number	Participant name	Participant short name	Country
1 *Beneficiary* 1	Facultés universitaires Notre-Dame de la Paix	LPS	Belgium
2 *Beneficiary* 2	Muszaki Fizikai es Anyagtudomanyi Kutatointezet - Magyar Tudomanyos Akademia	MFA	Hungary
3 *Beneficiary* 3	Istituto nazionale di Fisica Nucleare	LNF	Italy
4 *Beneficiary* 4	Vilniaus Universitetas	LPTDS	Lithuania
5 Partner 5	Belarusian State University	INP	Belarus
6 Partner 6	Emanuel Institute of Biochemical Physics - Russian Academy of Science	IBCP-RAS	Russia
7 Partner 7	Institute of Physics of National Academy of Science of Ukraine	IP-NASU	Ukraine

3. Project summary

Owing to very small dimensions of nanostructures in one or more directions, spatial confinement of charge carriers is fully achieved, providing thereby a discrete spectrum of their energy states. In addition, intrinsic spatial inhomogeneity of nanostructures dictates nanoscale inhomogeneity of the surrounding electromagnetic fields. Therefore, understanding the properties of nanostructures requires to deal with the intricate characters of their atomic structure, electronic structure and electromagnetic environment. Coming within the scope of this new field of "nano-electromagnetics", the present project aims at understanding how and why carbon nanostructures might have interesting electromagnetic properties. The core of the project is the development, the experimental validation and the exploitation of a consistent theory of the electromagnetic response in radio, microwave and THz frequency ranges of regular carbon nanostructures and polymer composites based on nanocarbons. In particular, the project intends:
- to provide a forum for scientists specialized in different areas of the nanocarbon, and nanocarbon materials synthesis and applications; - to interpret experimental electromagnetic data collected;
- to define physical grounds and to perform experiments for the design of a new generation of ultra-light materials with controlled electromagnetic properties;
- to explore the possibility of using chemically-modified nanocarbons in "thin" bio-medical and nanophotonics applications.
At this aim, seven teams belonging to three different scientific areas will joint efforts. The partners will equally contribute to the achievements of the objective of this multi-disciplinary project by bringing their expertise in condensed-matter physics, electromagnetic theory, and applied electromagnetism. The research efforts, both theoretical and experimental, are articulated around four work packages all involving strong collaborative links and knowledge transfer across the consortium.

Carbon-nanotube-based terahertz-to-optics rectenna, EU FP7 project FP7-612285 **CANTOR**, Call ID FP7-PEOPLE-2013-IRSES, **2013-2017**

SEVENTH FRAMEWORK PROGRAMME
THE PEOPLE PROGRAMME

International Research Staff Exchange Scheme

Annex I - "Description of Work"

PART A

1. *Grant agreement* details

Full Title: Carbon-nanotube-based terahertz-to-optics rectenna

Acronym: CANTOR

Proposal Number: 612285

Scientific Panel: Physics

Grant Agreement Number: PIRSES-GA-2013-612285

Duration of the project: 48 months

2. List of participants (*beneficiaries* and partner organisations)

Participant Number	Participant name	Participant short name	Country
1 *Beneficiary* 1 (coordinator)	University of Exeter	UNEXE	United Kingdom
2 *Beneficiary* 2	Tel Aviv University, School of Electrical Engineering, Faculty of Engineering, Department of Physical Electronics,	TAU	Israel
3 Partner* 3	Belarusian State University, Institute for Nuclear Problems	Belorussian State Uni	Belarus

**in Part B of Annex I, the abbreviation INP is used as participant short name instead Belorussian State Uni*

3. Project summary

The efficiency of traditional semiconductor solar cells is the subject of a fundamental limitation known as the Shockley-Queisser recombination limit, and is found to be near 30%. The invention in the early eighties of solar cell rectifying antennas (rectennas) – a combination of an optical antenna and a rectifying diode to efficiently absorb the incident solar radiation and directly convert the ac field across the antenna into the dc power - provides a way to overcome the limitation. Recent rapid technological progress in the design of different nano-dimensional structures gives rise to a new promising possibility in designing nanorectennas. A solar cell will incorporate a large array of such elements, which provide high conversion efficiency, and can be produced cheaply in a roll-to-roll process. However, practical realization of such devices requires precise theoretical modeling and experimental study to provide optimization of the antenna and nanocontact configuration. The project focuses on the physics and theoretical modelling of nanorectenna performance. The rectification effect comes from the photo-assisted charge carrier tunneling through a nanogap. For the efficiency enhancement, we propose using the coherent effect of the photon dressing of the electron-hole pairs. Theoretical modeling will be carried out on the basis of the Landauer- Büttiker formalism extended to the case of photon-dressed electrons. The fundamental thermodynamic limitation of the rectenna efficiency and prospective applications of the device are to be studied. This multidisciplinary and challenging project relies on the complementary expertise of the consortium teams and is based on the original approach - nanoelectromagnetics - combining electrodynamics of mesoscopic inhomogeneous media and the quantum theory of electronic ensembles with reduced dimensionality.

Nano-Thin and Micro-Sized Carbons: Toward Electromagnetic Compatibility Application, project FP7-610875 **NAMICEMC**, Call ID FP7-PEOPLE-2013-IRSES, **2013-2017**

SEVENTH FRAMEWORK PROGRAMME
THE PEOPLE PROGRAMME

International Research Staff Exchange Scheme

Annex I - "Description of Work"

PART A

1. *Grant agreement* details

Full Title: Nano-thin and micro-sized carbons: Toward electromagnetic compatibility application

Acronym: NAmiceMC

Proposal Number: 610875

Scientific Panel: physics

Grant Agreement Number: PIRSES-GA-2013-610875

Duration of the project: 48 months

2. List of participants (*beneficiaries* and partner organisations)

Participant Number	Participant name	Participant short name	Country
1 *Beneficiary** 1 (coordinator)	University of Lorraine	UL	France
2 *Beneficiary* 2	Frascati National Laboratory at the National Institute of Nuclear Physics	LNF INFN	Italy
4 Partner** 3	Belarus State University, Institute for Nuclear Problems	INP BSU	Belarus

** Beneficiary: EU/AC Institution*
*** Partner: Other Third Country Institution*

3. Project summary

The remarkable properties of high-surface area carbons, compatible in that with carbon nanotubes, provide a tremendous opportunity for fabrication, even at very low filler concentrations, of composites with outstanding electrical and electromagnetic properties. Due to their multifunctional properties, carbon/polymer composites can be widely used as relatively low weight and ultra-thin effective electric and optical components, as well as electromagnetic (EM) shielding and absorbing coatings. At the same time, ultra-lightweight carbon foams, being highly conductive, are expected to have very high EM shielding ability due to their cellular structure. Moreover, carbon foams have extremely low cost, and demonstrate outstanding thermal insulation / fire resistant and good mechanical properties. Along with polymer/carbon composites and highly conducting porous carbon monoliths, one more very attractive object for investigation its electromagnetic properties is ultrathin carbonaceous film - pyrolytic carbon or a few layer graphene. We expect that they could absorb up to 50% of the incident microwave power despite the fact that their thickness is only a small fraction of the skin depth. The idea of the project is to provide comparative study of EM shielding effectiveness of carbon foams, carbon ultra-thin films and epoxy/carbon composites with low filler concentration in microwave frequency range and to support the experimental data with an adequate theoretical model of materials' electromagnetics. On the basis of our theoretical simulations and experimental database collected within the project implementation, we intent to contribute into solution of one of the most challenging problem in material science: to develop EM coating through design-oriented-approach.

Institutional Development of Applied Nanoelectromagnetics: Belarus in ERA Widening, EU FP7 **BY-NanoERA** project FP7-266529, Call ID FP7-**INCO**-2010-6, **2010-2013**

Coordinator Prof. S. Maksimenko

The Belarusian State University Award named by Academician A.N. Sevchenko - for the work "Electromagnetics of nanostructures".

NANOMEETING 2011
24-27 May 2011, Minsk, Belarus

A Special Session "Nanoelectromagnetics" at the International conference on Physics, Chemistry and Applications of Nanostructures "Nanomeeting 2011", May 24-29, 2011.

Nanoscience and Nanotechnology 2011 INFN, Frascati, 26-30 September 2011. A special school-type one-day session devoted to topics of interest of the EU project BY-NanoERA.

A Special Session "Electrodynamics of nanowires and nanotubes" headed by Dr. G. Slepyan (INP) at the Int. Conference on Electromagnetics in Advanced Applications, September 12-17 2011, Torino, Italy.

FANEM' 12
25th anniversary of the Research Institute for Nuclear Problems

A special tutorial "Emerging Nanoscientific Developments" has been presented by 6 key lectures and 11 invited talks.

S.A. Maksimenko
Challenges and Perspectives in Nanoscale Electromagnetics

www.nano.bsu.by

Lead partner:
Research Institute for Nuclear Problems BSU,
220030, Belarus
11 Bobruiskaya Str.,Minsk
www.inp.bsu.by

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Director,
Project Coordinator
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Fax +375 17 226 51 24
polina.kuzhir@gmail.com

BY-NanoERA is founded by the European Union's 7th Framework Programme. The call identifier: FP7-INCO-2010-6. Grant no: 266529. The duration of the project is 36 months: from November, 1, 2010 until October, 31, 2013.

BY-NanoERA

Institutional Development of Applied Nanoelectromagnetics: Belarus in ERA Widening

Fp7 INCO.2010-6.1 Grant no: 266529

www.nano.bsu.by

oped for INP BSU will be proposed and disseminated as a model for the integration of the other Belarus teams into European Research Area.

The project partners work together on three work packages:

1. Framing and supporting the INP BSU's research activities and institutional development of NEM.
2. Facilitating INP BSU's research potential, information exchange and identifying partners.
3. Training for INP BSU's competence building and facilitating its participation in FP7.

In the last decade a new research discipline – nanoelectromagnetics – has been introduced as a synthesis of classical microwave electrodynamics and present-day concepts of the condensed matterphysics.

As a principal goal, the proposed project implies:
Reinforcement of the cooperation capacities of INP BSU in ERA through the institutional development of the new research discipline – applied nanoelectromagnetics.

On this way, a set of coupled tasks must be solved:

- To prove necessity and promising capability of NEM in the core objective of FP7 Theme 4 'NMP' and to develop a concept of nanoelectromagnetics as a perspective direction in NMP;
- To develop the strategy of INP BSU as a focus institution for the applied NEM evolution on the national and European levels;
- To establish network with research centers in MS or AC in applied NEM aimed with the progress in solving concrete research problems and submission of joint INCO proposals;
- To develop training modules to build competency and facilitate the participation in FP7 of INP BSU;
- To organize a set of workshops and seminars on NEM;
- To propose the reinforcement scheme developed for INP BSU as a model for the Belarus teams' incorporation into ERA.

Key directions of the work:

I. Electromagnetic waves and signal propagation in nano-sized components and integrated nano-structured systems; electromagnetic compatibility problem on the nano scale.
II. Electromagnetic response properties of composite materials with nano inclusions; electromagnetic shielding materials; nanocarbon in electromagnetic applications; nanocarbon based metamaterials.
III. Ionizing radiation shielding materials; boron, boron nitride and chemically modified (doped) carbon nanotube-based composite materials.
IV. Heat transfer on nano scale and in nanocomposites exposed to high-frequency fields.
V. Nanocarbon in medical applications; far-infrared and terahertz range thermolysis of cancer cells.

BY-NanoERA Consortium

Project Coordinator:

Research Institute for Nuclear Problems BSU, Belarus

Project Partners:

- Institut für Festkörperphysik TUB, Germany
- OLEM, Institute of Mechanics-BAS, Bulgaria
- National Institute Nuclear Physics, Italy
- Institute of Electronic Structure and Laser, Greece
- Institute of System Analysis and Information Support, Belarus
- Scientific & Technological Park of BNTU "Polytechnic", Belarus

Scientific links in Consortium

STRATEGY
of the Institute of Nuclear Problems of the Belarusian State University long-term development in the area of NanoElectroMagnetics

Developed under the FP7 BY-NanoERA project
supported by the European Commission

2. STRATEGIC VISION

2.1 Vision & mission

FACING THE FUTURE: By 2025, the INP BSU will become a center of excellence in Nanoelectromagnetics benefiting from its leading position in Belarus nanotechnology community and complete integration in the European Research Area. In alliance with the Belarusian State University, it will be an important center of nanoscience education and innovations in Belarus and Eastern Europe.

It will be also well recognized in the areas of nanoscale thermodynamics; physics of ionizing radiation interaction with the nanosized objects and spin physics of nanostructures.

The INP BSU realizes its mission in

1) carrying out the highest quality research in NEM and connected areas to support the Belarus nanotechnological research endeavor and further increase partnerships with world class research centers and industrial companies in the country and outside it to apply the research results in such social challenges as
   - *Higher and post-graduate education,*
   - *Secure, clean and efficient energy,*
   - *Health, demographic change and wellbeing;*

2) maintaining the Institute's scientific vigour by continuous renewal and updating of its research interests and skills and providing wide opportunities to its staff for career development along their professional life,

3) training and developing high quality young researchers.

The ambitious vision and mission stated above will be achieved in the case of availability of the following main interdependent pre-conditions, each equally critical for the success of the INP BSU:

1) an updated research program in which the modern trends in NEM and its applications are reflected, as well as research–industry interactions and commercialization aspects,
2) sufficient and stable financing,
3) enhanced international partnerships which, above highly performing research players, include industry and innovation intermediaries,
4) highly qualified and motivated core team working in close contact with the host University,
5) appropriate research infrastructure,

Graphene-Based Revolutions in ICT And Beyond
GRAPHENE
Grant agreement number 604391
CP-CSA

February 2, 2014

Multi-layered sandwich graphene devices
(MILESAGE)

Поданные на конкурсы европейские проекты: **Graphene Flagship**

Основой стали текущие проекты
IRSES
FP7 IRSES Cacomel,
FP7 IRSES FAEMCAR,
FP7 IRSES NAmiceMC

и проект INCO By-NanoERA

Université de Nam
61 Rue de Bruxell
B-5000 Namur, Belgiu
Philippe Lamb
+32-817247
philippe.lambin@unamur.

Table 2.2a. Recent and ongoing scientific projects involving at least two of the present partners P1 to P8.

Project	Period	P1	P2	P3	P4	P5	P6	P7	P8
FP7-ICT-2007.8.1 FET Proactive 1: Nano-scale ICT devices and systems "Carbon nanotube technology for high-speed nano-interconnects" CATHERINE	2009-2011					x	x		
FP7-INCO-2010-6 "Institutional Development of Applied Nanoelectromagnetics: Belarus in ERA Widening" BY-NanoERA	2010-2013				x		x	x	x
FP7-PEOPLE-2009-IRSES "Nano carbon based components and materials for high frequency electronics" CACOMEL	2010-2014			x	x				
FP7-PEOPLE-2012-IRSES "Fundamental and Applied Electromagnetics of Nano-Carbons" FAEMCAR	2012-2016	x	x		x		x		
FP7-PEOPLE-2013-IRSES "Nano-Thin and Micro-Sized Carbons: Toward Electromagnetic Compatibility Application" NAMICEMC	2013-2017				x		x		

201303

Received

NATO Internal use

SPS:

Emerging Security Challenges Division

Science for Peace and Security Programme

PROJECT Application

NATO Emerging Security Challenges Division, SPS Programme, Bd. Léopold III, B-1110 Brussels, Belgium
Send applications to sps.applications@hq.nato.int

Project Title *80 characters maximum, including spaces. Please select a title that is comprehensible to the non-specialist*

Electromagnetic Interference Shield based on High Surface Area Carbon

SPS Key Priority/Priorities *please use the numbering and nomenclature from the guidelines*

1) Facilitate mutually beneficial cooperation on issues of common interest, including international efforts to meet emerging security challenges
a) Counter-Terrorism
i) Methods for the protection of critical infrastructure, supplies and personnel

Project Duration *maximum 36 months*

36

NATO and Partner Country Project Directors

NATO Country Project Director (NPD)

Family Name	First Name	Title	Job Title
Celzard	Alain	Prof.	Professor

Institution	Address	Country
University of Lorraine	27 rue Philippe Séguin, CS 60036, 88026 Épinal Cedex	France

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Partner Country Project Director (PPD)

Family Name	First Name	Title	Job Title
Kuzhir	Polina	Dr.	Head of Laboratory

Institution	Address	Country
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Telephone	Fax	Email
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Поданные на конкурсы европейские проекты: **NATO SfP**

Основой стали текущие проекты IRSES

FP7 IRSES FAEMCAR,
FP7 IRSES NAmiceMC

и проект INCO By-NanoERA

Планируемые к подаче на конкурс H2020 RISE
Research and Innovation Staff Exchange
Call: H2020-MSCA-RISE-2014 проекты

Terahertz and Microwave Applications of Novel Carbon/Inorganic hybrid Nanostructures

Partnership Member	Legal Entity Short Name	Academic (Y/N)	Country
Beneficiaries			
Center of Physical Science and technology	CPST	Y	Lithuania
WEIZMANN INSTITUTE OF SCIENCE	WIS	Y	Israel
Institute of Mechanics, Bulgarian Academy of Sciences	IM-BAS	N	Bulgaria
Partner Organisations			
Belarusian State University, Research Instiotute for Nuclear Problems	INP BSU	Y	Belarus

Основой станут проекты IRSES

FP7 IRSES TerACaN

FP7 IRSES CANTOR

и проект INCO By-NanoERA

Collective Excitations in Advanced Nanostructures

Partnership Member	Legal Entity Short Name	Academic (Y/N)	Country
Beneficiaries			
Mediterranean Institute of Fundamental Physics	MIFP	Y	Italy
University of Exseter	EU	Y	UK
University of Eastern Finland	UEF	Y	Finland
University of Iceland	UI	Y	Iceland
Partner Organisations			
Belarus State University, Institute for Nuclear Problems	INP BSU	Y	Belarus
Erevan State University	ESU	Y	Armenia
De La Salle University	DLSU	Y	Philippines

Основой станут проекты IRSES

FP7 IRSES TerACaN

FP7 IRSES Cacomel

FP7 IRSES CANTOR

Поданные на конкурсы европейские проекты: COST

Основой стали роекты IRSES

FP7 IRSES TerACaN,
FP7 IRSES Cacomel,
FP7 IRSES FAEMCAR,
FP7 IRSES NAmiceMC
FP7 IRSES CANTOR

и проект INCO By-NanoERA

Title: Nanoelectromagnetics facing societal challenges

Acronym: NEMASO

Abstract:

The potential of nanosized elements and nanostructured materials for the manipulation of electromagnetic fields motivates the recent introduction of a new research discipline – nanoelectromagnetics (NEM) – which conceptually is a fusion of classical electrodynamics with novel methods and approaches of condensed matter physics. To move towards societal challenges for further ERA development, NEM needs an intensive interdisciplinary knowledge exchange between different scientific communities. As the crucial issue for success is involvement of industry along with academic research, actions targeting industry will be taken. We have letters of interest by several industries. The platform yielded by the project will be made available. Close contact with users will be kept through workshops, a web forum dealing with NEM fundamentals; NEM for electromagnetic, Biomedical and ICT applications; nanophotonics, photovoltaics and metamaterials, by a network of research groups as contact points.

PARTICIPANTS

Dr. Stefano Bellucci, coordinator, INFN, Italy

Dr. Maria Kafesaki, FORTH, Greece

Prof. Raluca Muller, IMT Bucharest, Romania

Prof. Rumiana Kostilkova, IMech-BAS (OLEM), Bulgaria

Prof. Vanessa Fierro, CNRS Institut Jean Lamour, France

Prof. Tamara Lobanova-Shunina, ISSP, Latvia

Prof. Irina Hussainova, University of Tartu, Estonia

Prof. Juras Banys, VU, Lithuania

Prof. Gregory Slepyan, TU, Tel Aviv, Israel

Prof. Yuri Svirko, UEF, Finland

Dr. Mikhail Portnoi, University of Exeter, UK

Prof. Sergey Maksimenko, INP BSU, Belarus

Prof. Akhlesh Lakhtakia, Penn. State Univ., USA

Dr. Geza Mark, MFA, Budapest, Hungary

Prof. Philippe Lambin, U Namur, Belgium

Prof. Axel Hoffmann, TUB, Berlin, Germany

Fundamental and Applied NanoElectroMagnetics

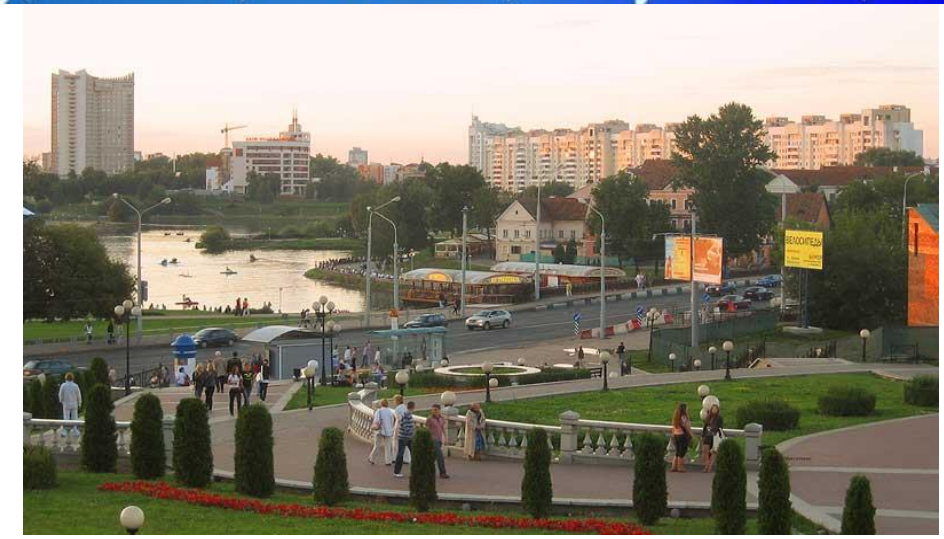
FANEM' 12

25th anniversary of the Research Institute for Nuclear Problems BSU

Belarusian State University, Minsk, Belarus, May 22-25, 2012

Chairmen: O. Ivashkevich
S.Maksimenko

Средний **h-фактор** приглашенных лекторов = **28**



Помимо FANEM 2012, НИИ ЯП БГУ организовал ряд Успешных спец-секций на международных конференциях, Включая Nanomeeting 2011 и 2013

www.nano.bsu.by/

Молодежные гранты

Гранты международной федерации ученых (World Federation of Scientists, National Scholarship Programme in the frame of the topic "Science and Technologies for Developing Countries")

Nonlinear optical properties of carbon nanotube composites, World Federation of Scientists, National Scholarship Programme in the frame of the topic "Science and Technologies for Developing Countries", 2004. Grant holder A. Nemilentsau under supervision of S.A. Maksimenko

Optical properties of carbon nanotube based composite medium, World Federation of Scientists, National Scholarship Programme in the frame of the topic "Science and Technologies for Developing Countries", 2008. Grant holder M. Shuba under supervision of S.A. Maksimenko

Грант международной федерации ученых (World Federation of Scientists, National Scholarship Programme in the frame of the topic "Science and Technologies for Developing Countries"). «Диэлектрические свойства полимерных композитных матермалов на основе наноуглерода», 2010/2011, Получатель гранта: аспирант Д.С. Быченок, научный руководитель: С. А. Максименко

Грант международной федерации ученых (World Federation of Scientists, National Scholarship Programme in the frame of the topic "Science and Technologies for Developing Countries"). «Rabi waves in quantum dot-based nanostructures», 2011/2012, Получатель гранта: аспирант Е.Ерчак, научный руководитель: Г.Я.Слепян

Грант международной федерации ученых (World Federation of Scientists, National Scholarship Programme in the frame of the topic "Science and Technologies for Developing Countries"). 2012/2013, Получатель гранта: аспирант О.Г. Поддубская, научный руководитель: С. А. Максименко.

Грант международной федерации ученых WFS Belarus National Scholarship Programme "Experimental study and theoretical simulations of electromagnetic response of carbon foams and polymer/nanocarbon composites", Получатель гранта Плющ А.О. Научный руководитель – Максименко С.А.

Молодежные гранты

Гранты РФФИ, конкурс "Научная работа молодых ученых из стран СНГ в российских научных организациях"

Грант РФФИ, конкурс "Научная работа молодых ученых из стран СНГ в российских научных организациях" МОБ_СНГ_СТ 2010 Г. "Научная работа молодого ученого немиленцева Андрея Михайловича из Белоруссии в Институте неорганической химии им. Курнакова РАН".

Грант РФФИ, конкурс "Научная работа молодых ученых из стран СНГ в российских научных организациях" МОБ_СНГ_СТ 2010 Г. и МОБ_СНГ_СТ 2011 Г. "Научная работа молодого ученого Быченка Дмитрия Сергеевича из Белоруссии в Институте Неорганической химии СО РАН"., Новосибирск, Грантополучатель Быченок Д.С.

Грант РФФИ № 13-02-90919 "Электронные свойства графеновых нанолент с зигзагообразно модифицированными краями", выполняемый Сороко В.А. в Федеральном государственном бюджетном учреждении науки Институте биохимической физики им. Н.М. Эмануэля Российской академии наук (ИБХФ РАН).

Грант РФФИ "мол_ин_нр" №13-03-90915, выполняемый Волынец Н.И. в Институте неорганической химии СО РАН (г. Новосибирск) в 2013 году под руководством доктора физ.-мат. наук А.В. Окотруба: «*Взаимодействие микроволнового излучения с композиционными материалами на основе химически модифицированного графена в полимерной матрице*».

Lithuanian State scholarship – 2 аспиранта

POCAONTAS

POSITION DESCRIPTION

MARIE CURIE ACTIONS

POCAONTAS Initial Training Network

The network "POCAONTAS" (POlymer – CArbOn NanoTubes Active Systems for photovoltaics) will develop innovative organic solar cells that combine high efficiency and high durability with low production cost. Organic solar cells are flexible, thin and pleasantly colored, so they integrate easily into building structures like, facades and windows. This opens up new markets where "classical" Silicon based solar cells cannot compete. However, before organic solar cells can enter mass production, their efficiency and long term stability must be enhanced significantly. Carbon nanotubes, due to their excellent electronic properties and stability, can help achieve these goals. The challenge is however to understand the interaction between polymers and Carbon nanotubes, and to achieve structural control on the nanoscale. The network POCAONTAS brings top European players together to tackle these issues on the nano-scale with cutting edge techniques, covering all areas from polymer design, advanced modeling, nanoscale spectro/microscopy up to state of the art device fabrication and characterization. "Leading companies in Photovoltaics (Eckectric Holding, Germany, Oryx Solar, Spain and others) will contribute their unique technological knowledge. One focus asset of the POCAONTAS network is the intense interaction between research institutes and industries, from which every fellow will strongly benefit. The network will hire 11 predoc-early stage researcher (ESR) students and 3 postdoc-experienced researcher(ER), and is committed to highest level interdisciplinary training and outreach. The candidates are expected to be mobile, e.g. they cannot apply for a fellowship in their home country."

Гранты БРФФИ для молодых ученых, Гранты Минобразования для студентов, аспирантов, магистрантов, гранты БГУ

Лучшая СНИЛ 2008 – 2010, 2011 и 2012 в БГУ в номинации Научно-исследовательская и инновационная деятельность

РЭСПУБЛІКА БЕЛАРУСЬ

БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ

ДИПЛОМ

Конкурс на лучшую студенческую научно-исследовательскую лабораторию по итогам 2008 – 2010 гг.

НАГРАЖДАЕТСЯ

Студенческая научно-исследовательская лаборатория

«Электромагнитные процессы в наноструктурах»

Руководители:

Максименко Сергей Афанасьевич,

Кужир Полина Павловна

Научно-исследовательский институт ядерных проблем

Победитель конкурса в номинации

Научно-исследовательская и инновационная деятельность

Ректор С. В. Абламейко

Приказ ректора БГУ
от 12.04.2011 г. № 538-ЛК

Theory of optical scattering by achiral carbon nanotubes and their potential as optical nanoantennas

GY Slepyan, **MV Shuba**, SA Maksimenko, A Lakhtakia - Physical Review B, 2006 - APS

Among a variety of different nanostructures, quasione-dimensional carbon macromolecules called carbon nanotubes1 CNTs are the subject of intense research worldwide—largely because of their unique electronic properties. It is well known that, depending on the ...

Цитируется: 131 Похожие статьи Все версии статьи (3) Импортировать в BibTeX Ещё

Electromagnetic wave propagation in an almost circular bundle of closely packed metallic carbon nanotubes

MV Shuba, SA Maksimenko, A Lakhtakia - Physical Review B, 2007 - APS

Carbon nanotubes CNTs have been the subjects of intensive research in the area of nanotechnology for about 15 years, 1 yet understanding of their fundamental physics is far from complete. One topic under intensive investigation is their electromagnetic response. ...

Цитируется: 68 Похожие статьи Все версии статьи (6) Импортировать в BibTeX Ещё

Theory of multiwall carbon nanotubes as waveguides and antennas in the infrared and the visible regimes

MV Shuba, GY Slepyan, SA Maksimenko, C Thomsen... - Physical Review B, 2009 - APS

Their unusual physical and chemical properties and their potential applications in a variety of nanotechnologies make carbon nanotubes CNTs very interesting objects to technoscientists 1, 2 despite possible health hazards. 3 In particular, CNTs have been ...

Цитируется: 56 Похожие статьи Все версии статьи (7) Импортировать в BibTeX Ещё

Terahertz conductivity peak in composite materials containing carbon nanotubes: Theory interpretation of experiment

GY Slepyan, **MV Shuba**, SA Maksimenko, C Thomsen... - Physical Review B, 2010 - APS

Carbon nanotubes CNTs Ref. 1—single-or multiwalled hexagonal networks of carbon atoms rolled up into cylinders—are extensively studied as potential components of high-frequency electronic circuits, such as transmission lines, 2 interconnects, 3 and antennas. 4–11 ...

Цитируется: 46 Похожие статьи Все версии статьи (4) Импортировать в BibTeX Ещё

Carbon nanotube antenna: far-field, near-field and thermal-noise properties

..., GY Slepyan, AM Nemilentsau, **MV Shuba** - Physica E: Low- ..., 2008 - Elsevier

A theory of the metallic achiral carbon nanotube (CNT) as a vibrator antenna is presented. The Leontovich–Levin integral equations method has been extended to the case of CNTs. Integral equations for the finite-length CNT and CNT bundles have been solved ...

Цитируется: 25 Похожие статьи Все версии статьи (3) Импортировать в BibTeX Ещё

Substitutional doping of carbon nanotubes to control their electromagnetic characteristic

AM Nemilentsau, **MV Shuba**, GY Slepyan, PP Kuzhir... - Physical Review B, 2010 - APS

Materials containing metallic carbon nanotubes CNTs can be used for the effective manipulation of the electromagnetic fields in the megahertz MHz, gigahertz GHz, and terahertz THz regimes. Particularly, for the rapidly emerging areas of THz sensing and ...

Цитируется: 13 Похожие статьи Все версии статьи (3) Импортировать в BibTeX Ещё

Radiofrequency field absorption by carbon nanotubes embedded in a conductive host

MV Shuba, GY Slepyan, SA Maksimenko... - Journal of Applied ..., 2010 - ieeexplore.ieee.org

Abstract Understanding the electromagnetic response of carbon nanotubes (CNTs) in the radio frequency range is very important for experimental development of therapeutic and diagnostic CNT applications, including selective thermolysis of cancer cells and ...

Цитируется: 14 Похожие статьи Все версии статьи (6) Импортировать в BibTeX Ещё

Absorption cross-section and near-field enhancement in finite-length carbon nanotubes i terahertz-to-optical range

MV Shuba, SA Maksimenko, GY Slepyan - arXiv preprint arXiv:0806.2954, 2008 - arxiv.org

Abstract: Electromagnetic characteristics of single-walled finite-length carbon nanotubes-absorption cross-section and field enhancement in the near zone-are theoretically studied in a wide frequency range from terahertz to visible. The analysis is based on the impedance- ...

Цитируется: 10 Похожие статьи Все версии статьи (4) Импортировать в BibTeX Ещё

Ведущий научный сотрудник Шуба М.В. получил премию БГУ им. А.Н. Севченко для молодых ученых.

Shuba, Mikhail V. (Mikhail V. Shuba)

Find potential author matches

Personal

Name	Shuba, Mikhail V.
Other formats	Shuba, M. Shuba, M. V. Shuba, Mikhail
Author ID	13609773100
Affiliation	Institute of Nuclear Problems Belarus, Minsk Belarus

Research

Documents	33	View Author Evaluator | Add to my list
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PHYSICAL REVIEW B **85**, 165435 (2012)

Experimental evidence of localized plasmon resonance in composite materials containing single-wall carbon nanotubes

M. V. Shuba, A. G. Paddubskaya, A. O. Plyushch, P. P. Kuzhir, G. Ya. Slepyan, and S. A. Maksimenko
Institute for Nuclear Problems, Belarus State University, Bobruiskaya 11, 220050 Minsk, Belarus

V. K. Ksenevich and P. Buka
Department of Physics, Belarus State University, Nezalezhnastsi Avenue 4, 220030 Minsk, Belarus

D. Seliuta, I. Kasalynas, J. Macutkevic, and G. Valusis
Center for Physical Sciences and Technology, A. Gostauto 11, LT-01108 Vilnius, Lithuania

C. Thomsen
Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

A. Lakhtakia
Nanoengineered Metamaterials Group, Department of Engineering Science and Mechanics, Pennsylvania State University, University Park, Pennsylvania 16802-6812, USA

PHYSICAL REVIEW B **81**, 205423 (2010)

Terahertz conductivity peak in composite materials containing carbon nanotubes: Theory and interpretation of experiment

G. Ya. Slepyan, M. V. Shuba, and S. A. Maksimenko
Institute for Nuclear Problems, Belarus State University, Bobruiskaya 11, 220050 Minsk, Belarus

C. Thomsen
Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, D-10623 Berlin, Germany

A. Lakhtakia

Projects visibility (2010-2013)

Invited talks: 10 (INP)
e.g. *2013 International Symposium on Electromagnetic Theory (Berlin)*

Talks: 73 in total, most of them are oral presentations

Papers published: 114 in total in PRB, APL, JAP, Nanotechnology,etc

Thin Solid Films 519 (2011) 4114–4118

Contents lists available at ScienceDirect

Thin Solid Films

journal homepage: www.elsevier.com/locate/tsf

Microwave probing of nanocarbon based epoxy resin composite films: Toward electromagnetic shielding

P. Kuzhir [a,*], A. Paddubskaya [a], D. Bychanok [a], A. Nemilentsau [a], M. Shuba [a], A. Plusch [a], S. Maksimenko [a], S. Bellucci [b], L. Coderoni [b], F. Micciulla [b], I. Sacco [b], G. Rinaldi [c], J. Macutkevic [d], D. Seliuta [d], G. Valusis [d], J. Banys [e]

Diamond & Related Materials 19 (2010) 91–99

Contents lists available at ScienceDirect

Diamond & Related Materials

journal homepage: www.elsevier.com/locate/diamond

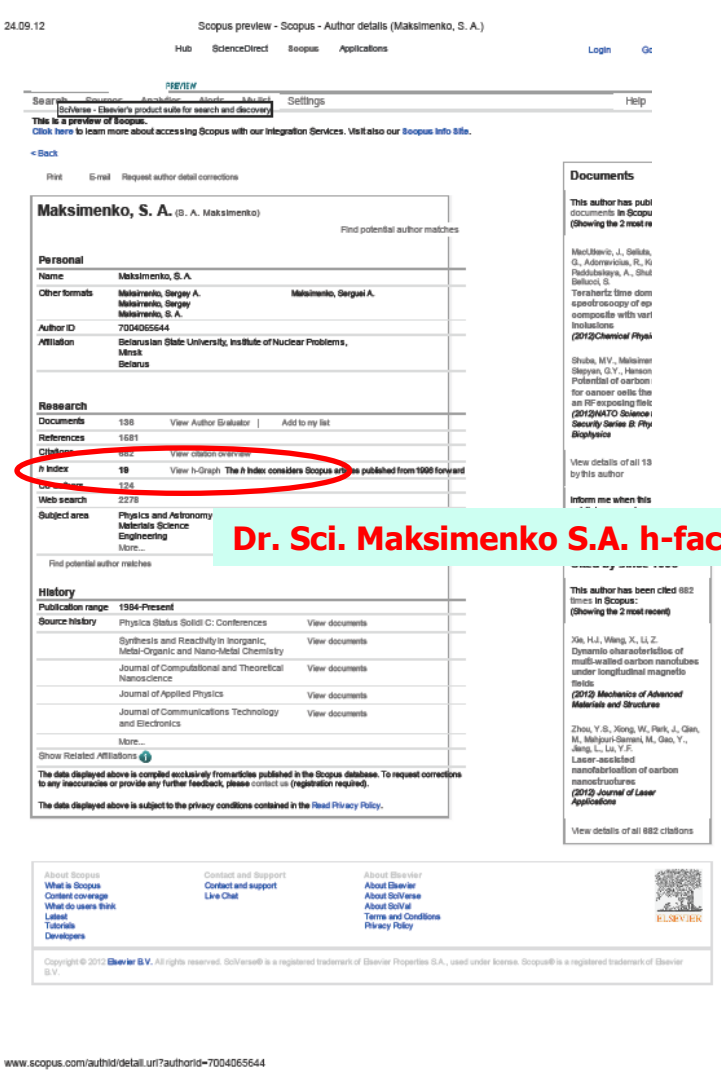
Dielectric properties of a novel high absorbing onion-like-carbon based polymer composite

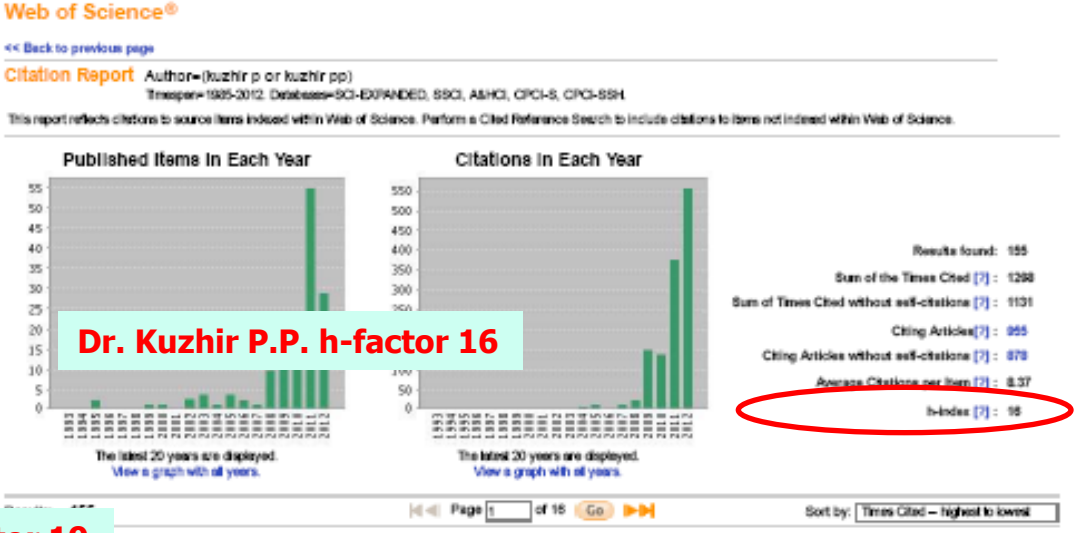
J. Macutkevic [a,*], P. Kuzhir [b,2], D. Seliuta [a,1], G. Valusis [a,1], J. Banys [c,3], A. Paddubskaya [b,2], D. Bychanok [b,2], G. Slepyan [b,2], S. Maksimenko [b,2], V. Kuznetsov [d,4], S. Moseenkov [d,4], O. Shenderova [e,5], A. Mayer [f,6], Ph. Lambin [f,6]

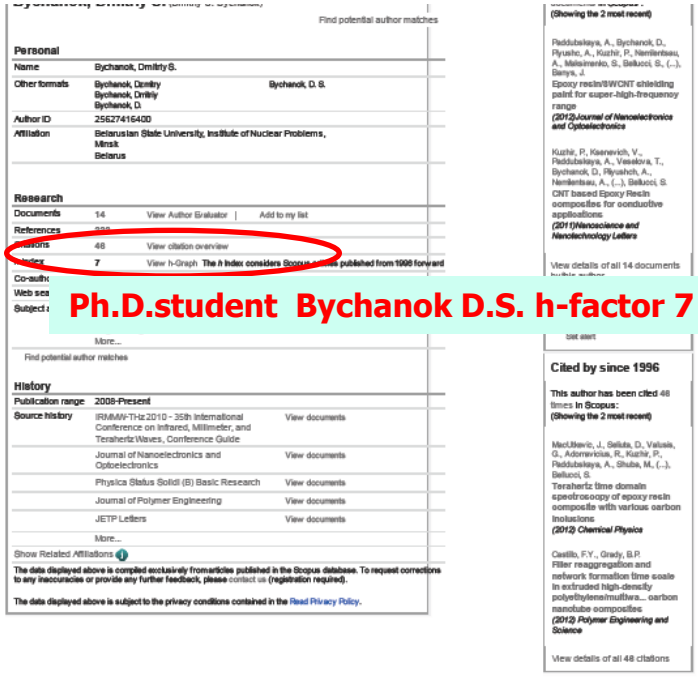
APPLIED PHYSICS LETTERS **97**, 073116 (2010)

Terahertz sensing with carbon nanotube layers coated on silica fibers: Carrier transport versus nanoantenna effects

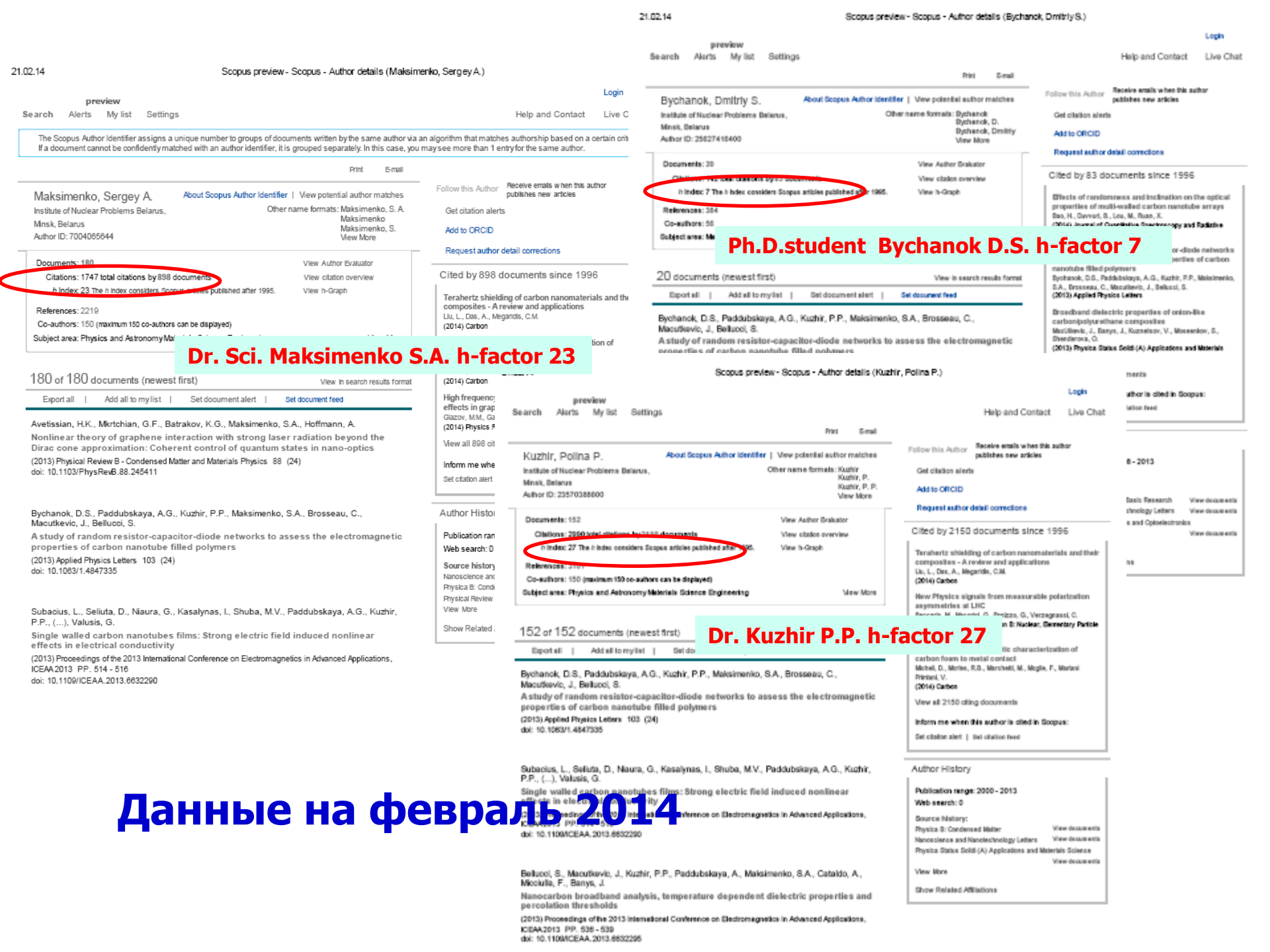
Dalius Seliuta,[1,2,a)] Irmantas Kašalynas,[1] Jan Macutkevic,[1] Gintaras Valušis,[1] Mikhail V. Shuba,[3] Polina P. Kuzhir,[3] Gregory Ya. Slepyan,[3] Sergey A. Maksimenko,[3] Vitaly K. Ksenevich,[4] Vladimir Samuilov,[5] and Qi Lu[5]







Данные на октябрь 2012


21.02.14
Scopus preview - Scopus - Author details (Maksimenko, Sergey A.)
Maksimenko, Sergey A.
Institute of Nuclear Problems Belarus,
Minsk, Belarus
Author ID: 7004065644
Documents: 180
Citations: 1747 total citations by 898 documents
h index: 23 The h index considers Scopus articles published after 1995.
References: 2219
Co-authors: 150 (maximum 150 co-authors can be displayed)
Dr. Sci. Maksimenko S.A. h-factor 23
Cited by 898 documents since 1996
180 of 180 documents (newest first)
Avetissian, H.K., Mkrtchian, G.F., Batrakov, K.G., Maksimenko, S.A., Hoffmann, A.
Nonlinear theory of graphene interaction with strong laser radiation beyond the Dirac cone approximation: Coherent control of quantum states in nano-optics
(2013) Physical Review B - Condensed Matter and Materials Physics 88 (24)
doi: 10.1103/PhysRevB.88.245411
Bychanok, D.S., Paddubskaya, A.G., Kuzhir, P.P., Maksimenko, S.A., Brosseau, C., Macutkevic, J., Bellucci, S.
A study of random resistor-capacitor-diode networks to assess the electromagnetic properties of carbon nanotube filled polymers
(2013) Applied Physics Letters 103 (24)
doi: 10.1063/1.4847335
Subacius, L., Seliuta, D., Niaura, G., Kasalynas, I., Shuba, M.V., Paddubskaya, A.G., Kuzhir, P.P., (...), Valusis, G.
Single walled carbon nanotubes films: Strong electric field induced nonlinear effects in electrical conductivity
(2013) Proceedings of the 2013 International Conference on Electromagnetics in Advanced Applications, ICEAA 2013 PP. 514 - 516
doi: 10.1109/ICEAA.2013.6632290
21.02.14
Scopus preview - Scopus - Author details (Bychanok, Dmitriy S.)
Bychanok, Dmitriy S.
Institute of Nuclear Problems Belarus,
Minsk, Belarus
Author ID: 25627416400
Documents: 20
h index: 7 The h index considers Scopus articles published after 1995.
References: 384
Co-authors: 58
Ph.D.student Bychanok D.S. h-factor 7
20 documents (newest first)
Bychanok, D.S., Paddubskaya, A.G., Kuzhir, P.P., Maksimenko, S.A., Brosseau, C., Macutkevic, J., Bellucci, S.
A study of random resistor-capacitor-diode networks to assess the electromagnetic properties of carbon nanotube filled polymers
Cited by 83 documents since 1996
Scopus preview - Scopus - Author details (Kuzhir, Polina P.)
Kuzhir, Polina P.
Institute of Nuclear Problems Belarus,
Minsk, Belarus
Author ID: 23570388600
Documents: 152
h index: 27 The h index considers Scopus articles published after 1995.
Co-authors: 150 (maximum 150 co-authors can be displayed)
Subject area: Physics and Astronomy Materials Science Engineering
Dr. Kuzhir P.P. h-factor 27
152 of 152 documents (newest first)
Bychanok, D.S., Paddubskaya, A.G., Kuzhir, P.P., Maksimenko, S.A., Brosseau, C., Macutkevic, J., Bellucci, S.
A study of random resistor-capacitor-diode networks to assess the electromagnetic properties of carbon nanotube filled polymers
(2013) Applied Physics Letters 103 (24)
doi: 10.1063/1.4847335
Subacius, L., Seliuta, D., Niaura, G., Kasalynas, I., Shuba, M.V., Paddubskaya, A.G., Kuzhir, P.P., (...), Valusis, G.
Single walled carbon nanotubes films: Strong electric field induced nonlinear effects in electrical conductivity
doi: 10.1109/ICEAA.2013.6632290
Bellucci, S., Macutkevic, J., Kuzhir, P.P., Paddubskaya, A., Maksimenko, S.A., Cataldo, A., Micciulla, F., Banys, J.
Nanocarbon broadband analysis, temperature dependent dielectric properties and percolation thresholds
(2013) Proceedings of the 2013 International Conference on Electromagnetics in Advanced Applications, ICEAA 2013 PP. 536 - 539
doi: 10.1109/ICEAA.2013.6632295
Author History
Publication range: 2000 - 2013
Web search: 0
Source history:
Physica B: Condensed Matter
Nanoscience and Nanotechnology Letters
Physica Status Solidi (A) Applications and Materials Science
Данные на февраль 2014

ВОЗМОЖНОСТИ в РФ:
Европа отнесла РФ к Индустриальным странам

1. **Российский научный фонд** «Проведение фундаментальных научных исследований и поисковых научных исследований отдельными научными группами»: **фундаментальные и поисковые НИР**
2. **Программа развития регионов**, и, в том числе науки в регионах: **прикладные НИР**
3. **Попадание** крупного университета в число 15-ти ВУЗов, которые РФ продвигает **в ТОП-100**. В х формируются или модернизируются "Центры исследований" и "Лаборатории мирового уровня", как структурные единицы Ведущего исследовательского университета под специально выделенные для этого средства: **международное сотрудничество с учеными с высоким рейтингом**

Роль международной мобильности в развитии научной лаборатории

рост авторитета в профессиональной среде

(H-factor, публикации в высоко-рейтинговых журналах,

организация конференций (спецсекций),

участие в профессиональных сообществах),

Новые источники финансирования,

подготовка, подача, получение и выполнение новых проектов

возможность привлечения научной молодежи и зрелых специалистов

к выполнению проектов,

углубление и/или расширение поля деятельности.

рост и усиление научной команды

Спасибо за внимание!

http://inp.bsu.by/

http://nano.bsu.by/