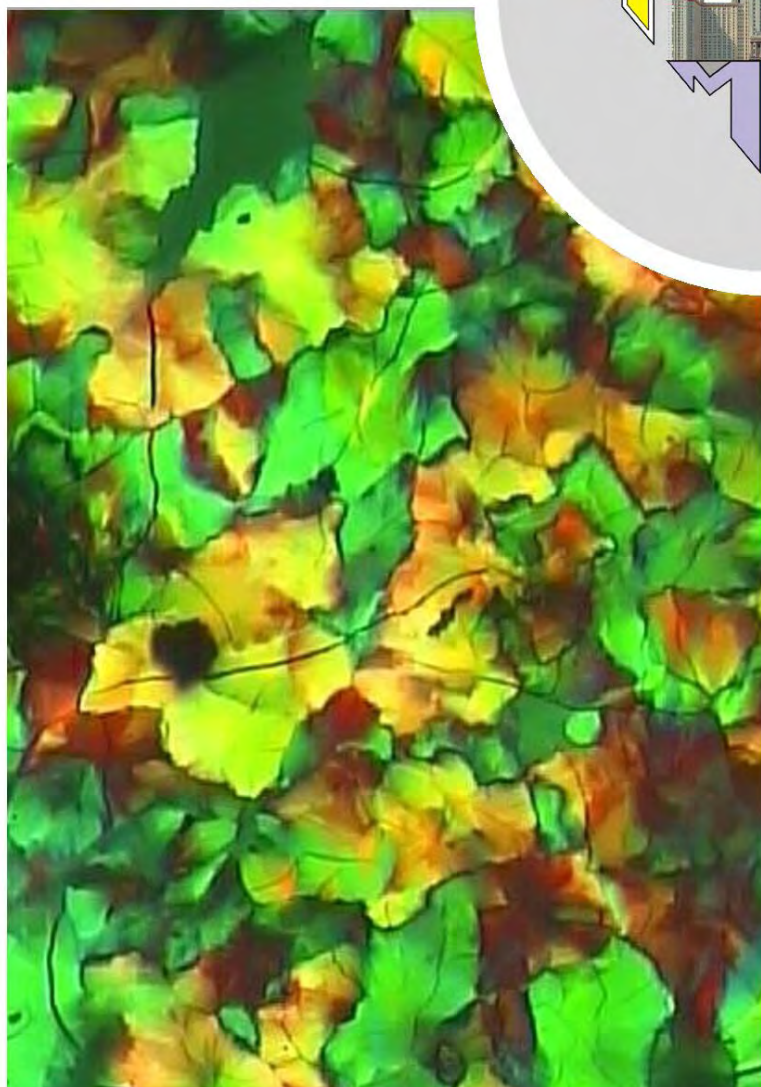


# **Lomonosov Moscow State University**



**Department  
of  
Materials  
Science**

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*I remember as Professor Yuri Tretyakov, who was the chairman of one of the leading divisions of Chemistry Department and full member of the RAS, came to my office and suggested to set up the absolutely new faculty - the High School of Materials Science. The High School, later recalled as the Department of Materials Science was created in proper time. By joint efforts of professors from different departments of Lomonosov Moscow State University, we succeeded in establishing quite new department within the classical university. This decision was motivated by the rapid development of natural sciences at the turn of the century, accommodated by the total interdisciplinary integration of sciences. This project predicted our needs in alternative education standards and selection of the most talented students able to become proficient in interdisciplinary sciences and, later, to develop them successfully.”*

**Rector of the Lomonosov Moscow State University,  
Vice president of the Russian Academy of Sciences  
Viktor A. Sadovnichy**



*“The Department of Materials Science, like all complex systems, evolves in the course of time. Two most important points, one in the past and the other in the future, I consider as the key stages in its evolution. The first key point in the Department’s history was reached in the period of huge political (the collapse of the USSR), global environmental (Chernobyl disaster) changes and at the same time in the period of outstanding scientific achievements (discovery of the high-temperature superconductivity) which stimulated the unprecedented pace of new technologies and materials development. The second point in the history of Materials Science Department will come in the future when the most talented graduates will determine its further progress taking the development of the Department as one of their major priorities. Only then we will be confident that we, who worked at “ground zero” of the Department of Materials Science, toiled not in vain and made a modest contribution to the future of our homeland.”*

**Dean of the Department of Materials Science of  
Lomonosov Moscow State University,  
Full Member of the Russian Academy of Sciences  
Yury D. Tretyakov**



## 1. THE HISTORY OF THE DEPARTMENT

The **Department of Materials Science** traces its history back to 1991. The necessity to have a department of materials science as a part of the classical university was forced by the primary needs of developing science and technologies at the turn of the century that was essential especially in the cross-disciplinary areas.

The **Higher School of Materials Science (HSMS)**,

reorganized later into the department, appeared on the basis of three faculties – Department of Chemistry, Department of Physics and Department of Mechanics and Mathematics; and so the interdisciplinary approach underlies the educational program of the Department. The advanced professors of these faculties were engaged as lecturers. Our students and alumni are researchers who acquired good skills at experimental work and profound strong theoretical background in natural sciences. They complete a number of special theoretical courses and do practical work and advanced training in mathematics, chemistry, physics and mechanics. A special emphasis is put on foreign languages acquisition (English and French). Additionally, students study the humanities, including History and Art History, Philosophy and Economics.

The main difference in Department's education methodology is extensive emphasis on student's scientific research and creation of an environment that facilitates scientific creativity. This is accomplished by custom-tailored education plan, weekly hands-on laboratory practice, student participation in conferences and scientific events.

Many alumni from the Department achieved success in different fields of fundamental and applied science, education services and other science-intensive activities, in part due to extensive theoretical and practical training that they receive as students.



*MSU Pro-Rector, Full Member of the Russian Academy of Sciences (RAS)  
Viktor A. Sadovnichy and  
Full Member of the Russian Academy of Sciences Valery A. Legasov  
were the originators of the Department*

## 2. THE DEPARTMENT TODAY

### 2.1. Administration



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*Junior students in the chemical laboratory*

## **2.2. Education**

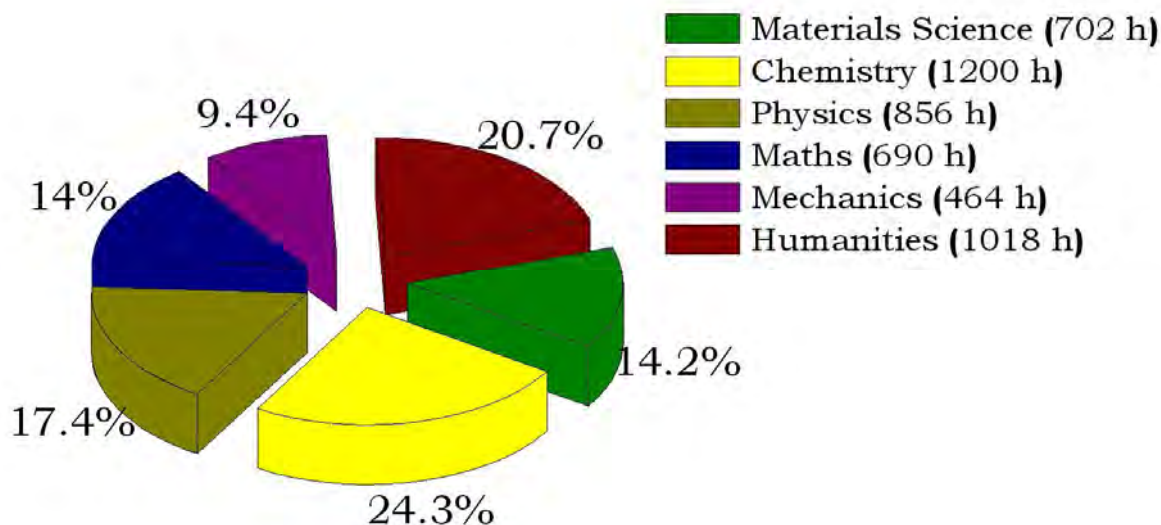
### **2.2.1. Admission and Education**

Education process at the Department is based on dual Bachelor/Master degree program (DBMD). Each year the Department has 25 state-funded open positions for first-year students; 5 additional positions are for commercial education. Such a small intake of students is a deliberate choice intended on individual training program for each student.

In June-July period the Admission Committee of the Department receives application forms from young people intended to become students of bachelor or master degree programs. Russian applicants should demonstrate best results in Russian State Examination and/or honor diplomas of the regional, national or international competitions for school students, Olympiads, and successfully pass examination on mathematics. Foreign applicants should also pass examinations on Russian, chemistry and physics. Annually, the Admission Committee of the Department receives a few applications for every announced position.



*Core curriculum in percents and hours:*



After four years successful bachelor study students are awarded the diploma which evidences their professional research skills in «Chemistry, physics and mechanics of materials». Then the graduate students could successfully pass exams to become students of Master's degree program and specialize in chemistry and materials science for next two years.

To create motivation and healthy competition among students, the Academic Council of the Department announces student rating curve every six weeks. This reflects the summary of student achievements, such as grades on written assignments, performance in one-on-one colloquium discussions, and final exam grades.



*Our alumni of Bachelor's program with administration and professors of the Department (2009)*



*Our alumni of Master's program 2010*

### **2.2.2. Diploma**

Today the SAC for master degree examination is formed by 24 high-qualified specialists from leading research institutes of RAS and universities, half of them are full members or corresponding members of Russian Academy of Sciences (RAS). Since 2006 the SAC chairman is director of Frumkin Institute of Physical Chemistry and Electrochemistry Arslan Yu. Tsivadze.

The Department of Materials Science was one of the first departments of the University that introduced the dual bachelor's and master's degree program (DBMD). The second SAC was set up in June 2006 as a committee for analysis of bachelor projects. Since 2008 the chairman of SAC for bachelor degree is full member of RAS Vyacheslav M. Buznik.

By tradition, representatives of the Russian and international business and Russian government administration are invited as guests to the diploma presentations of our graduates.

Since 1998 the most advanced graduate students become PhD students at the Department in order to become specialists of high qualification in materials science and chemistry.





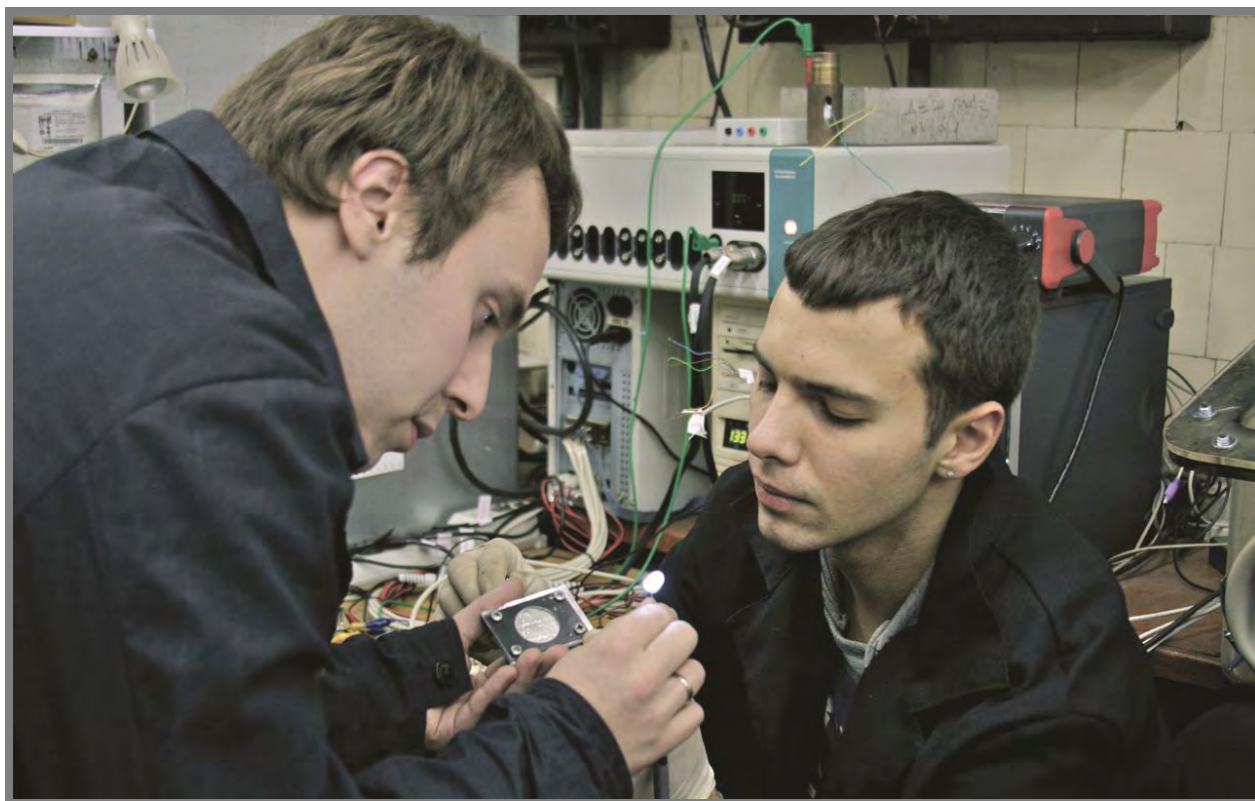
*The habilitation talk of Alexey V. Lukashin – the graduate of the Department of Materials Science (December 2009)*

### **2.2.3. Doctorate**

Annually 12-13 graduates become PhD students of the Department. The education period for PhD students is 3 years. Since 2009 the doctorate acceptance preliminary examination is done once per year – in autumn. Currently more than 30 young specialists are PhD students of the Department.

The committee of highest academic qualifications approves doctorate degrees in solid state chemistry, in inorganic chemistry, and in physics of condensed matter. Each candidate for doctoral degree has more than 10 publications leaving behind most of young doctors of other departments. Our PhD students that successfully defended their thesis are able to continue their education as habilitation students.

Most of the graduates of the Department become fellows of research institutes and universities; however our graduates are also among representatives of the industrial circles, members of research press and mass media. Most of graduates living abroad are academics and staff of the best universities and international research centers.

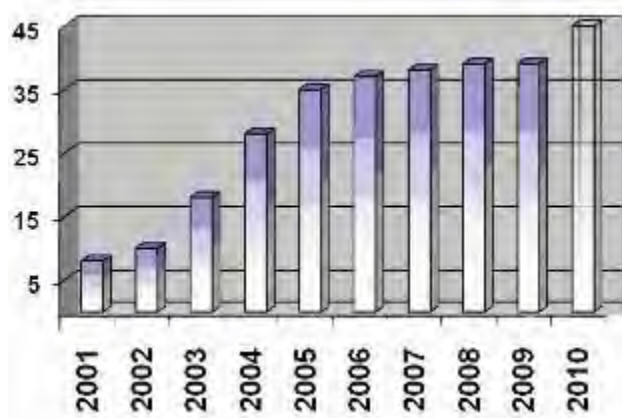


*Practical studies in nanotechnology*

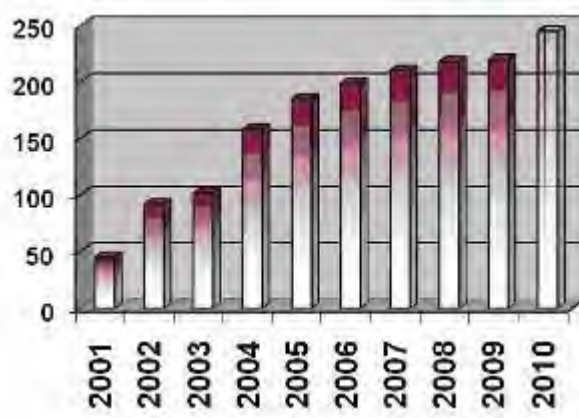
## 2.3. Research

### 2.3.1. Development Concept

Most of staff members, PhD and diploma students are involved in the development of new classes of functional nanomaterials and take part in international and domestic projects devoted to the same research area. Numerous awards received at the most prestigious national and international conferences and high-rank publications in prestigious scientific journals confirm the excellence and the world-wide recognition of works produced by the Department staff.



*The total number of research papers published by the Department members per year*



*The number of scientific grants received by the Department members*



### **2.3.2. Equipment**

Considerable part of the Department's equipment is collected at the Multiple-Access Center "Technologies of New Nanostructured Materials Preparation and Their Complex Characterization" (MAC). This center is equipped with the most up-to-date facilities that ensure the implementation of modern interdisciplinary scientific projects and helps compete with the best universities and research centers. The equipment assembled there is sufficient to provide solutions for academic, scientific and production tasks. During the course of the Master's degree program all students have practical training in the MAC as a required course: students of the Materials Science Department have an opportunity to have a special training in applying analytical methods and tools of the research center and to obtain an Operator Training Certificate. The MAC is also available to the students for their research projects.

#### **X-ray Equipment:**

- X-ray Diffractometer with a Rotating-Anode X-ray tube D/MAX-2500V/PC ultraX 18 (Rigaku)
- Powder Diffractometer STADI P (STOE)
- Single Crystal Diffractometer CAD-4 (ENRAF)

#### **Spectroscopic Equipment:**

- Atomic Emission Spectrometer Optima 5300DV with Laser Ablation System SOLIS LSX-500 (Perkin-Elmer)
- UV-vis Spectrophotometer Lambda 35 (Perkin-Elmer)
- Infrared Spectrophotometer Spectrum One (Perkin-Elmer)
- Luminescence Spectrometer LS-55 completed with attachments (Perkin-Elmer)
- Raman Microscope inVia Reflex (Renishaw)
- Scanning Spectrophotometer UV/VIS/NIR Spectrophotometer Lambda 950 with Optical Bench (Perkin-Elmer)

#### **Mass-Spectrometer Equipment:**

- Mass-Spectrometer ELAN DRC-II (Perkin-Elmer)
- Ion and Neutral Particle Mass-Analyzer Macc INA-3 (Leybold-Herau)
- High Resolution Gas Chromatograph with Mass Selective Detector CLARUS 600 (Perkin-Elmer)
- Laser Mass-Spectrometer LAMMA-1000 (Leybold-Heraus)

#### **Equipment for Electrophysical, Electrochemical and Magnetic Measurements:**

- SQUID Magnetometer S700 with VSM Module (Cryogenic)
- Measuring Set for Complex Susceptibility SCC (APD Cryogenics)
- Electrochemical System of Potentiostat Solartron 1287 and Harmonic Analyzer Solartron 1255B (Solartron)



### **Microscopic Equipment:**

- Transmission Electron Microscope JEM-2000 FXII (JEOL)
- High-Resolution Scanning Election Microscope Supra 50VP (LEO, Germany) with Microanalysis System INCA Energy+ (Oxford) \*\*
- Light Petrographic Microscope Eclipse 600pol with Thermostat Holder (Nikon)
- Light Microscope METAM PB-21 (LOMO)
- Microscope NTEGRA Aura (NT-MDT) with Adjustable External Magnetic Field

### **Thermoanalytical Equipment:**

- Differential Thermal and Thermo Gravimetry Analyzer Diamond Pyris TG/DTA (Perkin-Elmer)

### **Other Equipment:**

- Surface Analyzer Nova 4200e (Quantachrome) \*
- System for Nanoparticles Characterization Zetasizer Nano ZS (Malvern)
- Laser Particle Sizer AnalyzEtte 22 (FRITSCH)
- Freeze Dryer FreeZone 18 (Labconco)
- Protector Glove Box CA with Controlled Atmosphere (Labconco)
- Planetary Ball Mill Pulverizette 5 Series (FRITSCH)
- Presses for Chill/ Warm Pressing (up to 250-500°C) (CARVER)
- Tube and Chamber (Box) Furnaces of different types up to 1200-1350°C (Nabertherm), Three-Zone-Fired Furnace (Carbolite)
- High Pressure Automated System (Parr)
- System of Planar Structure Formation by 3D Printing LP 50 (PixDro)
- Data Collection and Processing System Power Edge (Dell)

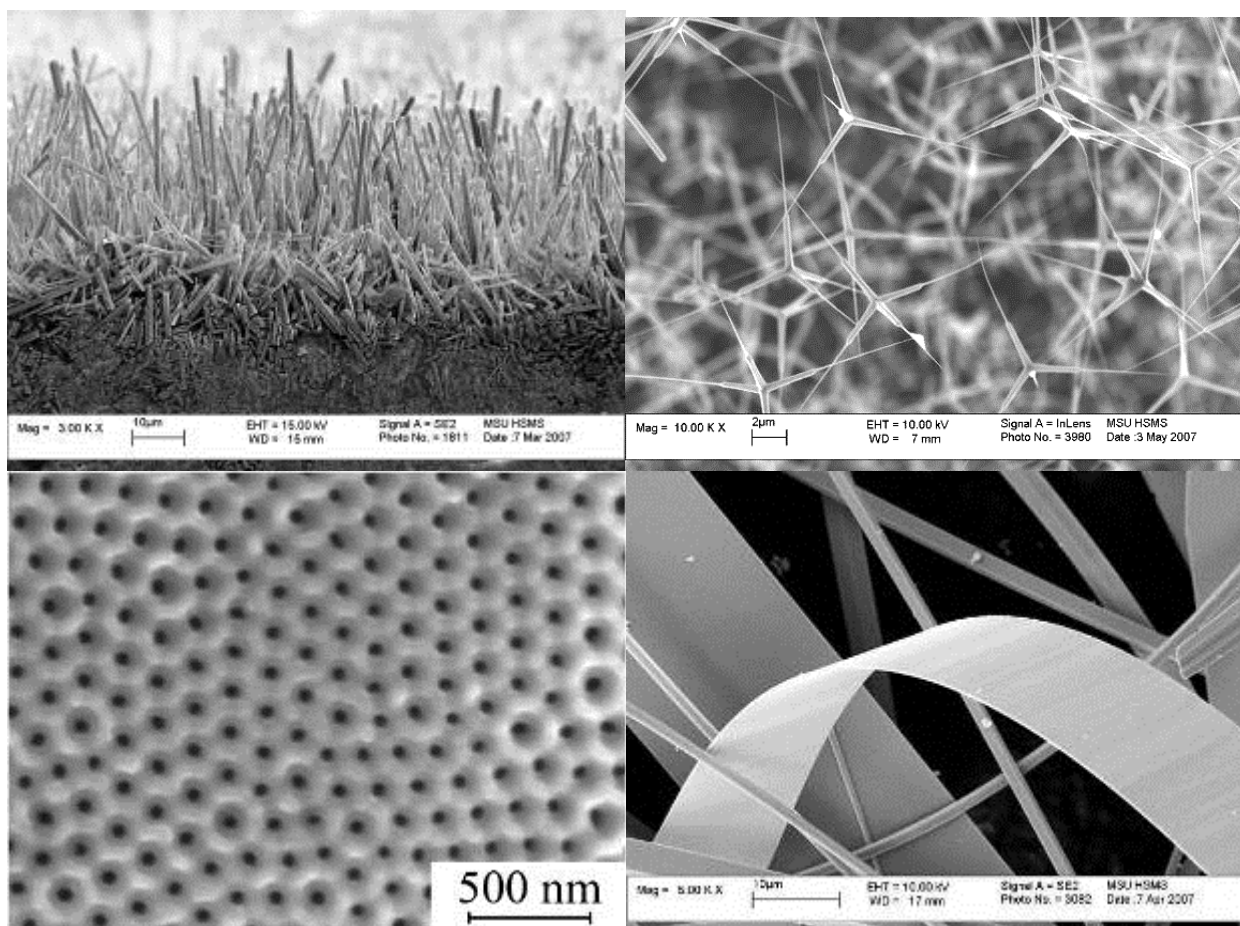




*Vice Chairman of the Government of the Russian Federation Sergey B. Ivanov and CEO of the Russian Corporation for Nanotechnologies RUSNANO Anatoly B. Chubais reward the Department's graduate E. A. Pomeransteva who won the competition of young scientists held at The International Nanotechnology Forum Rusnanotech*

### **2.3.3. Student Research Awards**

Among the honors of students of the Department of Materials Science there are prestigious national and international awards. Among them are individual grants from industry giants such as RAO UES, Gazprom, UC RUSAL, LG Chemistry Ltd., Haldor Topsoe A/S, and others. Our students are the winners of young participant awards at well-known international meetings and symposia such as EMRS, MRS, RUSNANOForum, International Online Nanotechnology Olympiad "NANNOS" and many other awards for the youth. Annually, the students of the Department get individual grants from the President and the Government of Russian Federation; Moscow Mayor, Municipality and Government of Moscow, the Rector and Academic Council of Lomonosov Moscow State University, stipendiary of Russian Academy of Sciences (RAS).



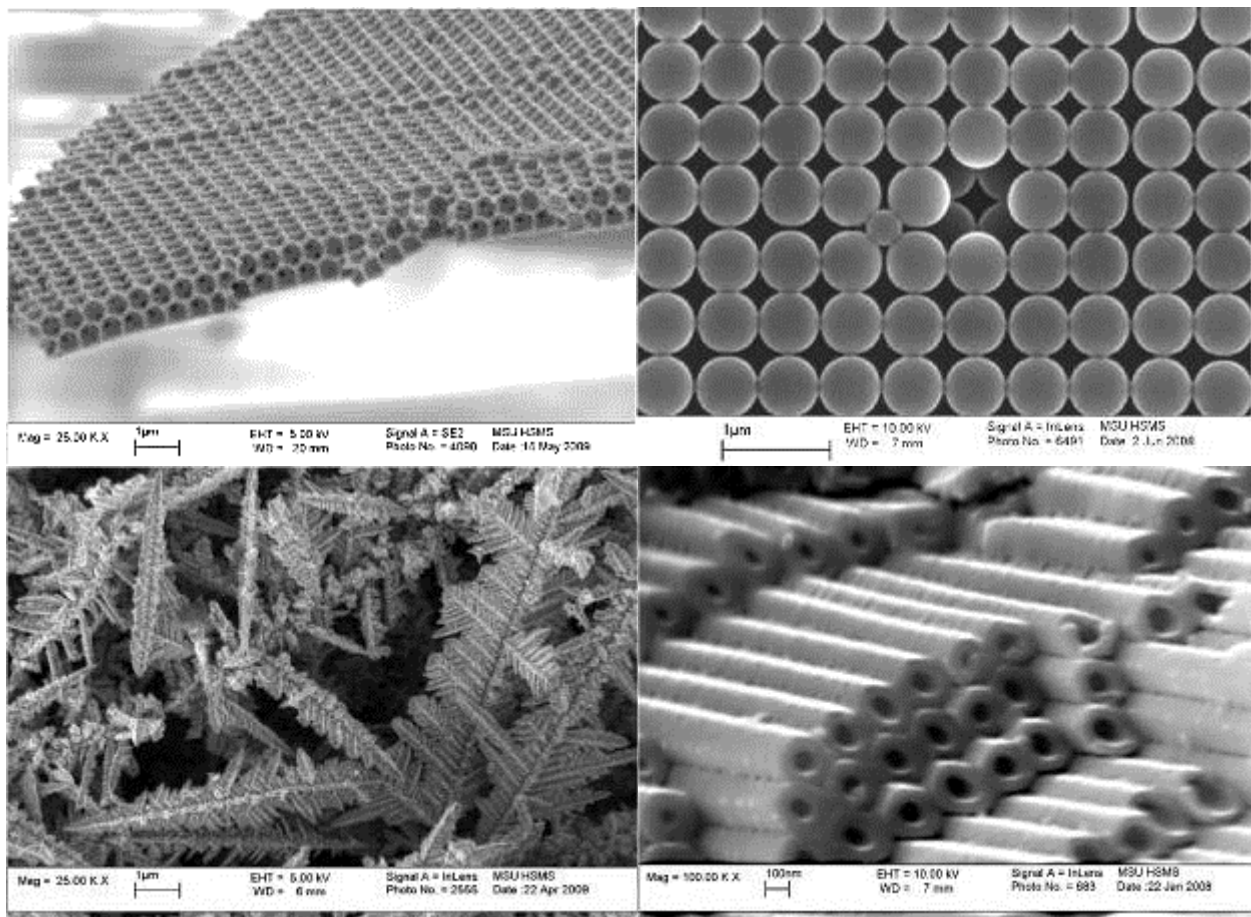
### 2.3.4. Research Priorities

Staffs of the Department carry out research aimed at creation of new materials and technologies, including:

- Nanocomposites based on single-walled carbon nanotubes and clusters of dielectrics, ionic conductors and semiconductors intercalated into inner pores of nanotubes (halogenides; K, Cu, Ag, Fe, Co, Ni; chalcogens; chalcogenides Zn, Cd, Pb);
- Hybrid materials based on conjugated polymers and nanocrystalline ZnO with outstanding luminescent behaviour;
- Development of chemical design methods for magnetic nanocomposites of solid nanoreactors for devices with ultrahigh recording density (up to  $10^3$  Gb/cm<sup>2</sup>) based on arranged anisotropic nanoparticles of Fe, Co and Ni;
- Development of transparent conducting printing inks based on colloidal particles of co-precipitated hydrated tin and antimony oxides  $Sb_xSn_{1-x}O_2$  for application as transducer material in gas sensors;
- Synthesis of hybrid nanoparticles of  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> covered by naturally occurred humic acid shells promising for early stages cancer diagnostics and treatment by magnetic hyperthermia method;
- Synthesis technology for catalytic membranes based on porous alumina efficient in separation of gas mixtures;



- Development of novel efficient synthesis methods for one-dimensional oxide nanostructures applicable in soft oxidation catalysis and power engineering;
- Development of the production methods for barium zirconate and cerate-based high-density ceramics for high-temperature barrier materials applications;
- Optimization of CVD methodology for stabilized zirconia thin films synthesis promising as heat-resistant coatings for aeronautical turbine blades;
- Development of novel approaches to cobaltite membranes production with high electronic/ionic conductivity;
- Manganite-based materials with colossal magnetoresistance (CMR) for magnetic sensors and spintronics (ceramics, thin films and tunnel heterostructure);
- Synthesis of various oxide materials with high ionic conductivity (cobaltites,  $\text{BiMeVO}_x$ , whiskers of one-dimensional superionic conductors) and polymer ionic conductors for fuel cell and power cell applications;
- Preparation of sodium titanate nanotubes by rapid expansion of supercritical solutions and by supercritical drying for photocatalytic degradation of organic compounds in potable water and industrial wastes.





*Postgraduate students at the VIII Conference of Solid State Chemistry (SSC) (Bratislava, Slovakia)*

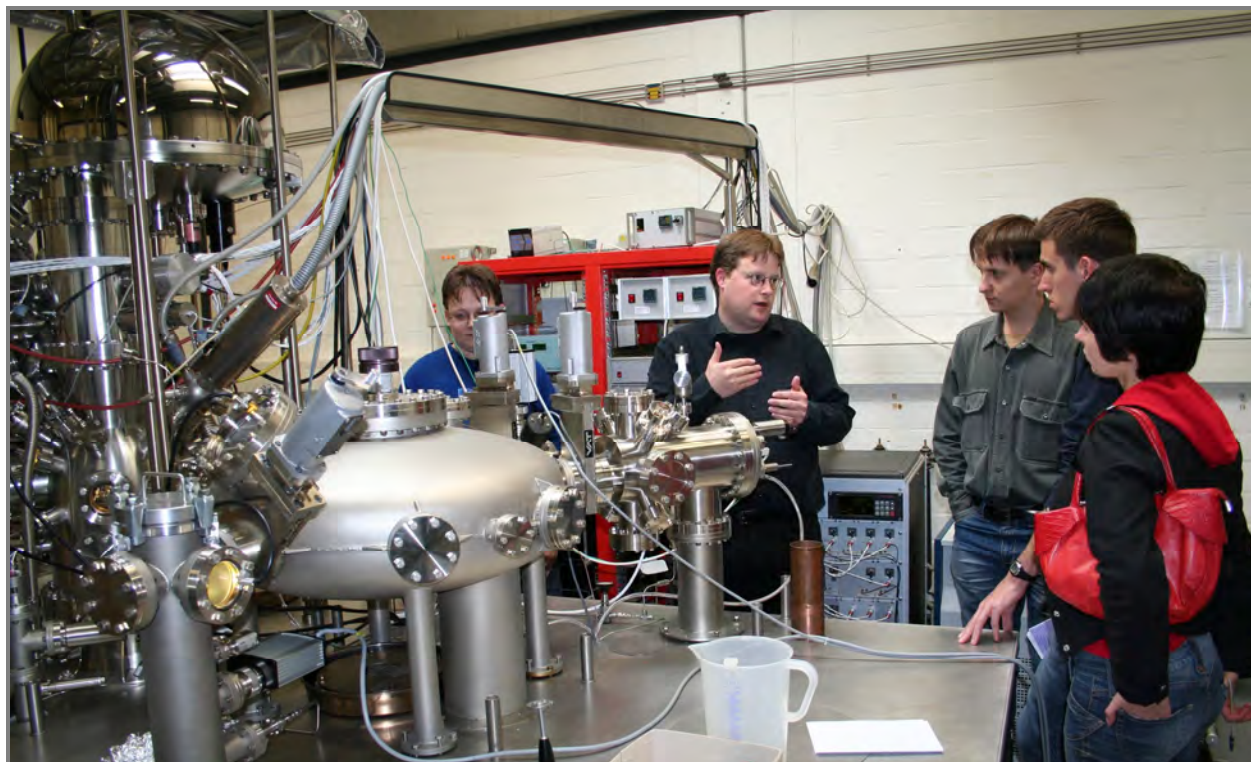
## **2.4. International Collaboration**

### **2.4.1. General Information**

The Department of Materials Science has wide connections with scientific research institutes in Europe, Asia and America. The increasing number of cooperation agreements allows execution of joint projects in international scientific teams, receiving grants from international scientific foundations and associations for collaborative research. Research and education projects of the Department are co-funded by DFG and DAAD (Germany), CNRS (France), CRDF and NSF (the USA), RFBR (Russia), NNSF (China) etc.

Flexible educational curriculum enables students to participate in conferences, undergo training in foreign universities during the first year of Master's degree program, to do combined postgraduate studies both in Russian and foreign laboratories. The Department cooperates closely on research projects with the leading European universities, mostly including German and French ones. More ties are being established with the universities of China, Japan and Korea year by year.

The Department of Materials Science encourages both undergraduate and postgraduate students to participate in national and international scientific conferences. Traditionally, the Department's staff and students take part in the International, European and National prestigious congresses and symposia.



*Participants of the summer school during the tour of research laboratories of the Department of Chemistry and Biochemistry at Ruhr University Bochum (Germany)*

#### **2.4.2. International Summer School in Materials Synthesis, Characterization and Properties**

International Summer School “Materials – Synthesis, Characterization and Properties” became one of the best Department’s traditions through financial support of the German Academic Exchange Service (DAAD). The first summer school took place in 2004 at Lomonosov Moscow State University and laid the foundation of the project. For the first time it gathered postgraduate students and staff of the Department of Materials Science and Ruhr University Bochum.

In October 2006 the second summer school took place at Ruhr University. There were 17 undergraduate and postgraduate students and staff of the Department out of 50 participants. The next Summer school will be held in autumn 2010.





### 2.4.3. Student Training and Exchange

*Ruhr University  
(Bochum, Germany)*



*Max Planck Institute for Solid State  
Research  
(Stuttgart, Germany)*



*National Institute for  
Materials Science of  
Japan (Tsukuba)*



*National Cheng-Kung  
University (Taiwan)*



*University of  
Duisburg-Essen  
(Germany)*



*Sun Yat-Sen University  
(Guangzhou, China)*



*Technology Center of BHP Billiton  
(Johannesburg, South Africa)*



#### **2.4.4. International Collaboration Agreements**

##### **Department of Chemistry of the University of Duisburg-Essen (Germany)**

In August 2006 the Department of Materials Science signed the collaboration agreement with the Department of Chemistry of the University of Duisburg-Essen (Germany). Under the terms of agreement, scientists carry out joint research into the preparation of calcium phosphate biomaterials that can replace bone tissue. The agreement allows scientific information exchange, academic conventions, scientific and educational projects set up.

##### **Karlsruhe University (Germany)**

In May 2009 the collaboration agreement with Karlsruhe University (Germany) was established. From the day of its signing the two universities initiated academic exchange of postgraduate students and young scientists as a part of the program “Sophisticated understanding and using of complex systems”.

##### **Saint-Gobain (France)**

Collaboration agreement between the Department of Materials Science and Saint Gobain (France) fosters joint scientific research, graduate student training in France, instituting the Saint Gobain award for best student and, finally, co-financing the young PhD employment at the Department.

##### **Sun Yat-Sen University (China)**

Sun Yat-sen University in Guangzhou is one of the biggest scientific centers of the South China. State Laboratory of Optoelectronic Materials and Technologies of the University is the leading center of optoelectronic materials in China. The Department established close scientific ties with the laboratory. At present, within the framework of this joint Russian-Chinese project, the scientists of two universities carry out the research on fluorescence composites.

##### **National Cheng-Kung University (Taiwan)**

In July 2008 the cooperation agreement with the Faculty of Fundamental and Applied Materials of the National Cheng-Kung University (Taiwan) was established. The foundation for this agreement was the positive results of joint research on such projects as “Research and development of arrays of magnetic nanowires in mesoporous matrices” and “Synthesis and study of highly-ordered optical materials based on solid nanoreactors”.

## 2.5. The NANOMETER – “A Virtual Nanotechnology Community”



[www.nanometer.ru](http://www.nanometer.ru)

**Web-site NANOMETER** - is created by a large community of readers, students and scientific groups of both enthusiasts and professionals. It represents an open system that is designed to organize nanotechnology community of Russia and to give equal opportunities to everyone to participate actively in nanotechnologies development. Hosting, administration, technical and informational support of the site are provided by the staff of Materials Science Department.

Web-site “Nanometer” publishes news, announcements and other information concerning all fields of natural science that were provided by different scientific groups and individuals. The site places priority on news about educational aspect of nanotechnologies and issues relating to interaction among science, society, business corporations and government institutions.

The web-site is also instrumental in the organization of International Online Nanotechnology Olympiads (e-NANNOS).



*Winners of The 2<sup>nd</sup> International Online Nanotechnology Olympiad  
«Nanotechnologies are breakthrough to the future!» (e-NANNOS'2008)*

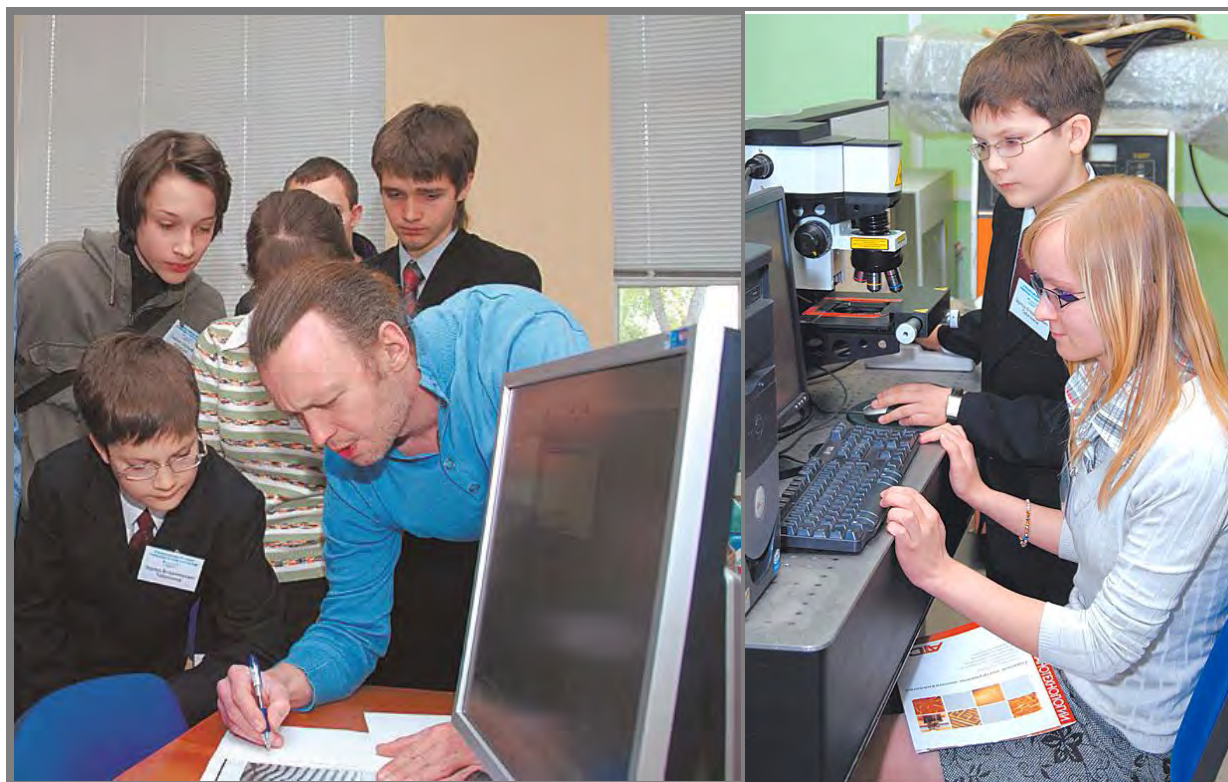


## 2.6. International Online Nanotechnology Olympiad



The Internet and Nanotechnologies are like the twins due to their importance and their roles played in development of human society in XXI century. That is why their symbiosis is so strong and successful. The first Online Nanotechnology Olympiad «Nanotechnologies are the breakthrough to the future!» (e-NANNOS'2007) was organized on the base of Lomonosov Moscow State University by staff and students of the Department. The official web-site of the Olympiad is [www.nanometer.ru](http://www.nanometer.ru). This competition follows the best traditions of international Olympic games; for all participants it was hard but of a great interest because the competition tasks originated from a new interdisciplinary field. Traditionally, online nanotechnology Olympiads held on spring and join together thousands of participants. The mean age of participants of e-NANNOS'2009 was 17.5. E-NANNOS'10 held on in March/April 2010 and joint about 6100 young participants from 81 regions of Russia and 31 other countries.

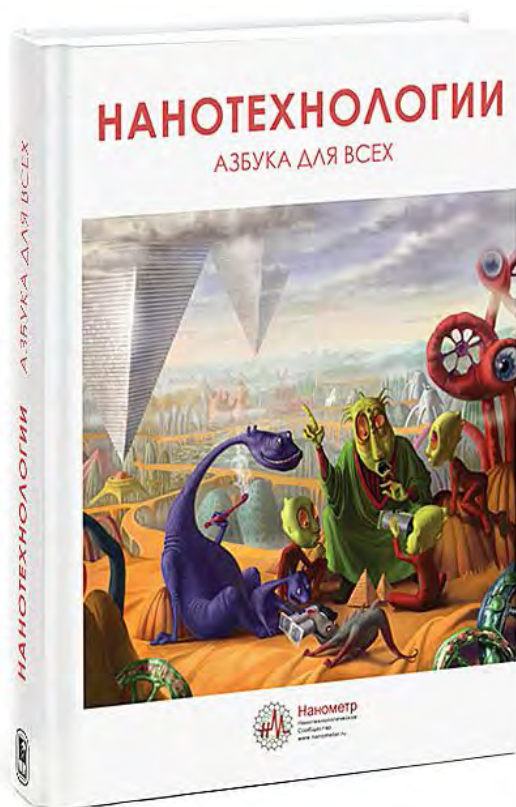
Since 2009, by the decision of the National Council of School Students Competitions, the winners of the annual Nanotechnology Olympiad have additional advantages over other applicants in being admitted to Russian universities.



*Participants of the experimental round of e-NANNOS'2008*

## 2.7. Publishing Activity

The Department's members pay special attention to curriculum development and publishing. Recently a new textbook «Functional nanomaterials» prepared by A. Eliseev and A. Lukashin was released.



The most important achievement of the Department of Materials Science is a considerable amount of scientific publications in Russian and foreign journals. The scientists and undergraduate students publish outstanding research results and scientific reviews.

The Department publishes monthly the news bulletin "Nanometer" dealing with everyday activity of staff and students including announcements, congratulations, reports about training and conferences. The bulletin also tells about exciting academic and extracurricular life at the Department, i.e. sports, the annual celebration of the Department's Day, competitions of student works.





## 2.8. Sport and Other Activities



*Our team in intellectual club “Brain-Ring” in 2005 and their prize*

Traditionally our students participate in different intellectual competitions and games. In 2005 the team of the Department won the first and the third prizes of the “Brain-Ring” intellectual club in Lomonosov Moscow State University round and in Moscow round respectively.

Most of the students are keen on sports: soccer, volleyball, basketball, track and field athletics; ski and swimming are also rather popular.



*Our student and candidate master of sports in gymnastics Polina Kocherginskaya (left) and soccer team of the Materials Science Department (right)*





*The years of education at the Department of Materials Science will always stay in my heart as mostly interesting and happy. Here I have obtained most substantial experience both in research and social interactions.*

**Artem Kovalenko,  
alumnus 2010**



*It is not a secret that the background, acquired by us here during last 6 years, is especially broad, deep and high-grade; and we, as the alumni, are able to deal with various research problems from any field of materials science.*

**Yaroslav Filippov,  
alumnus 2010**



*It is not really easy to be a student of the Materials Science Department, but finally our endeavor will be completely offset by friendliness of professors and staff, strong knowledge in materials science and ability to do what we love; the last is the most important.*

**Maria Efremova,  
2<sup>nd</sup> year student**

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Department of Materials Science

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For additional information see **[www.fnm.msu.ru](http://www.fnm.msu.ru)**