



## Curriculum Vitae

Rostislav V. LAPSHIN, Ph. D.

an experienced researcher-developer-microscopist in scanning probe microscopy and nanotechnology

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## SUMMARY

During successful career, a number of researches and developments were carried out which cover a broad range of topical problems in scanning probe microscopy and nanotechnology. Demonstrated inventiveness, ability to contribute original designs and generate new ideas. A number of solutions, methods, enhancements, algorithms, designs, and control techniques were suggested, confirmed experimentally, and presented to scientific community which increase accuracy and performance of measurements conducted on the scanning probe microscope.

Reputation of a specialist being able to cope with complex technical problems; to formulate perspective research plan; to issue a patent competently; to reveal a probable commercial future of the work; to deal with tasks that require interdisciplinary approach; to provide concept of an instrument at the system level; to evaluate a new technology; to analyze performance of components and systems via modeling and experiment.

Key skills include: development of measurement methods (theory and experiment); data acquisition, treatment, and analysis; mathematical modeling of crucial relationships; computer programming; report preparation; making up grant proposals; writing application notes and research papers.

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## PROFESSIONAL EMPLOYMENT

Term: January 1996 – present

Employer: Institute of Physical Problems named after F. V. Lukin

Department: Nanoelectronics

Laboratory: Solid Nanotechnology

Address: 5 Georgievskiy Avenue, Zelenograd, Moscow, 124460, Russian Federation

Field: Scanning probe microscopy and nanotechnology

Position: Staff scientist

Activities: As SPM-microscopist, participated in experimental STM/AFM investigations (ambient, low-energy plasma, HV, and UHV environments) of porous Si surface, GaAlAs heterostructures, ordered SiO<sub>2</sub> nanoparticles (opal photonic crystals), SiNbn superconductor microwave sensor, nanostructured electrochemically-polished Al, ordered porous Al<sub>2</sub>O<sub>3</sub>, Pd clusters, carbon nanotubes (CNT), surface ordered structures (MePhSiCl<sub>2</sub>, VOCl<sub>3</sub>, TiCl<sub>4</sub>, etc.) and other materials. Researched feature formation by local probe oxidation of thin films (Ti, Zr, WC, MoC, etc.) and by indenting a probe into plastic surface (Au, Al, Cu, polycarbonate, Langmuir-Blodgett film, etc.) to develop a record medium for a large capacity probe storage device (PSD). Made critical probe nanolithography to form a junction of a field-effect nanotransistor. Conducted investigations of thin carbon films plasma-deposited on low-density polyethylene (LDPE), polyurethane (PU), and poly(methyl methacrylate) (PMMA) in order to improve biocompatibility of artificial human implants (blood-vessels, crystalline lens, mitral valves, etc.) fabricated of these materials.

Discovered nanostructuring of spin-coated poly(methyl methacrylate) film in oxygen RF-plasma. Investigated influence of vacuum ultraviolet (VUV) on properties and surface morphology of poly(methyl methacrylate). Studied pores formation in highly oriented pyrolytic graphite (HOPG) treated in oxygen RF-plasma. Investigated formation of quantum dots of C, Ni, Si on Si(100) and Si(111) substrates in glow-discharge Ar-plasma. Developed a deposition process of catalytic Ni nanoparticles on Si(100) substrate that made possible a low-temperature synthesis of carbon nanostructures (CNS), viz. carbon nanotubes (CNT), carbon nanofibers (CNF), carbon nanospheres (CNS), and carbon nanotori by plasma-enhanced chemical vapor deposition (PECVD) method. Discovered a new box-shaped nanostructure of graphene and explained mechanism of its formation. Investigated surface morphology, properties and defects of fluorosilicate glass (FSG) and borophosphosilicate glass (BPSG) used as low-k dielectric layers in integrated circuits (IC).

As SPM-developer, solved task of automatic scanner calibration by natural standards such as crystal-line lattices. Elaborated a simple readback method for a probe storage device, which memory bits were represented by single atoms/molecules. Suggested a feature-oriented scanning-positioning methodology intended for implementation of high precision SPM-measurements, automatic surface characterization and unmanned bottom-up nanofabrication. Developed an automatic drift correction method built on techniques of counter-scanning and topography feature recognition. Built up an AFM-based setup and conduct measurements of bimaterial microcantilevers used as room-temperature IR-sensors. Formulated operation principles, suggested construction, and control methods of a high-precision versatile walking robot-nanopositioner intended for use in SPM and various nanotechnological processes. Developed a drift-insensitive method for automatic distributed calibration of probe microscope scanner in nanometer range by crystal lattice as a length standard.

Term: February 1990 – January 1996

Employer: "Delta" Microelectronics and Nanotechnology Research Institute

Department: Nanotechnology

Laboratory: Scanning Tunneling Microscopy

Address: 2 Schelkovskoye shosse, Moscow, 105122, Russian Federation

Field: Scanning tunneling microscopy

Position: Researcher

Activities: Worked on a fast-acting scanning tunneling microscope (STM), in particular, a fast-acting digital control system intended for tunnel junction stabilization. Developed a method correcting STM piezo-scanner nonlinearity and hysteresis. Within bounds of the above tasks carried out: formulation of technical requirements; prototype analysis; working-out of instrument concept and basic architecture solutions; building of a math model; engineering calculations and estimates; synthesis of flow-charts and operation algorithms; design of principle digital schemes (logic, ADC, DAC, i/o interface, embedded microcontroller); writing and debugging of a program kernel for microscope low-level control; design of calibration and self-testing routines; assemblage and test of the experimental STM.

Term: April 1988 – September 1989

Employer: Moscow State Technical University named after N. E. Bauman

Faculty: Computer Science and Control Systems

Department: Development and process engineering of electronic apparatus

Ad hoc creative team: "Rhythm"

Address: 2-ya Baumanskaya St., bldg. 5, Moscow, 107005, Russian Federation

Field: Precision mechanics

Position: Engineer

Activities: Developed a specialized equipment to balance video rotary heads of a tape recorder. Dealt with measurement automation, math data processing and sensor conjugation with a local controller.

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## ACHIEVEMENTS IN SCIENCE

- Explained methods of creation of the polygonal masonry from large stone blocks with complex curvilinear surfaces of conjugation in the megalithic complexes of Peru, 2021
- Suggested a productive method of distributed calibration of probe microscope scanner in nanometer range, 2016
- Suggested a method of precision determination of lattice spacing by beating (moiré) in STM scans, 2015

- Developed an improved analytical model for the approximation of hysteresis loop, 2015
- Suggested application of a hexagonal superlattice (HSL) on graphite as a length standard in nanometer range, 2014
- Suggested a mechanism of formation of the 3D box-shaped graphene (BSG) nanostructure, 2013
- Measured topography and parameters of the hexagonal superstructure (HSS) on surface of highly oriented pyrolytic graphite (HOPG) with high-precision & high spatial resolution by applying feature-oriented scanning (FOS) approach, 2012
- Discovered a new kind of hexagonal superstructure (HSS) on surface of highly oriented pyrolytic graphite (HOPG), 2012
- Discovered and described a box-shaped graphene (BSG) nanostructure originated from mechanical cleavage of pyrolytic graphite monocrystal, 2011
- Detected and explained low contrast periodic changes in lateral sizes of unit cells at STM images of crystal surfaces, 2011
- Conducted drift-insensitive distributed calibration of a probe microscope scanner in nanometer scale by crystal lattice as a length standard, 2011
- Proposed and experimentally approved a new method for preparation of catalytic nanoparticles (CNP) of controlled sizes in a glow-discharge plasma, 2011
- Formulated operation principles, suggested construction, and control methods of a versatile miniature walking robot-nanopositioner intended for high-precision manipulation of samples, substrates, micro/nanosensors, and micro/nanotools, 2010
- Developed a deposition process of catalytic nickel nanoparticles (NNP) making possible a low-temperature synthesis of carbon nanostructures (CNS) by plasma-enhanced chemical vapor deposition (PECVD) method, 2009
- Demonstrated smoothing of nanoscale asperities of poly(methyl methacrylate) (PMMA) surface under vacuum ultraviolet irradiation, 2008
- Discovered a nanostructuring and partial ordering of poly(methyl methacrylate) (PMMA) surface treated in oxygen radio-frequency plasma, 2006
- Suggested a novel drift-insensitive distributed approach for calibration of a probe microscope scanner in nanometer scale by natural measures, 2005
- Developed a new counter-scanning technique intended for automatic correction of scan distortions induced by probe drift relative to a sample surface, 2000
- Proposed, developed and experimentally proved an original feature-oriented scanning (FOS) methodology applicable for both high precision surface measurements, nanometrology, and unmanned bottom-up nanofabrication, 1999
- With a scanning tunneling microscope (STM) conducted a distance measurement between two surface atoms of the highest ever done before precision, 1999
- Suggested a new feature-oriented scanning (FOS) method notably improving resolution of a scanning probe microscope (SPM), 1999
- First conducted at room temperature a low-noise scanning tunneling spectroscopy (STS) localized precisely on a single surface atom, 1999
- First demonstrated on crystal surface a probe tracking by single atoms as data bits of a high-capacity probe storage, 1998
- Suggested and justified a ring calibration structure for scanner calibration of a scanning probe microscope (SPM), 1998
- Proposed an original approximating model for hysteresis that permits to effectively correct nonlinearity of a probe microscope piezoscanner, 1993
- Suggested a novel concept, control method, and design of a fast-acting scanning tunneling microscope which may serve as a platform for building a high-performance nanoassembler, 1993

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## **SELECTED PUBLICATIONS**

- R. V. Lapshin, *An improved parametric model for hysteresis loop approximation*, Review of Scientific Instruments, vol. 91, iss. 6, no. 065106, 31 pp., 2020
- R. V. Lapshin, *Drift-insensitive distributed calibration of probe microscope scanner in nanometer range: Real mode*, Applied Surface Science, vol. 470, pp. 1122-1129, 2019
- R. V. Lapshin, *Drift-insensitive distributed calibration of probe microscope scanner in nanometer range: Virtual mode*, Applied Surface Science, vol. 378, pp. 530-539, 2016

- R. V. Lapshin, *STM observation of a box-shaped graphene nanostructure appeared after mechanical cleavage of pyrolytic graphite*, Applied Surface Science, vol. 360, part B, pp. 451-460, 2016
  - R. V. Lapshin, *Drift-insensitive distributed calibration of probe microscope scanner in nanometer range: Approach description*, Applied Surface Science, vol. 359, pp. 629-636, 2015
  - R. V. Lapshin, A. P. Alekhin, A. G. Kirilenko, S. L. Odintsov, V. A. Krotkov, *Vacuum ultraviolet smoothing of nanometer-scale asperities of poly(methyl methacrylate) surface*, Journal of Surface Investigation. X-ray, Synchrotron and Neutron Techniques, vol. 4, no. 1, pp. 1-11, 2010
  - R. V. Lapshin, *Automatic drift elimination in probe microscope images based on techniques of counter-scanning and topography feature recognition*, Measurement Science and Technology, vol. 18, iss. 3, pp. 907-927, 2007
  - R. V. Lapshin, *Feature-oriented scanning methodology for probe microscopy and nanotechnology*, Nanotechnology, vol. 15, iss. 9, pp. 1135-1151, 2004
  - R. V. Lapshin, *Object-oriented scanning for probe microscopy and nanotechnology*, Ph. D. thesis (in Russian), Moscow, 2002
  - R. V. Lapshin, *Digital data readback for a probe storage device*, Review of Scientific Instruments, vol. 71, no. 12, pp. 4607-4610, 2000
  - R. V. Lapshin, *Automatic lateral calibration of tunneling microscope scanners*, Review of Scientific Instruments, vol. 69, no. 9, pp. 3268-3276, 1998
  - R. V. Lapshin, *Analytical model for the approximation of hysteresis loop and its application to the scanning tunneling microscope*, Review of Scientific Instruments, vol. 66, no. 9, pp. 4718-4730, 1995
  - R. V. Lapshin, O. V. Obyedkov, *Fast-acting piezoactuator and digital feedback loop for scanning tunneling microscopes*, Review of Scientific Instruments, vol. 64, no. 10, pp. 2883-2887, 1993
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### BOOK CHAPTERS

- R. V. Lapshin, *Feature-oriented scanning probe microscopy*, Encyclopedia of Nanoscience and Nanotechnology, edited by H. S. Nalwa, vol. 14, pp. 105-115, American Scientific Publishers, 2011
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### PATENTS

- R. V. Lapshin, P. V. Azanov, *Device and method to produce nanoparticles*, Patent of Russian Federation, no. 2,476,620, September 12, 2011
  - R. V. Lapshin, *Walking robot-nanopositioner and method of controlling movement thereof*, Patent of Russian Federation, no. 2,540,283, May 26, 2010
  - R. V. Lapshin, *Method of correction of surface images obtained using scanning probe microscope and distorted with drift*, Patent of Russian Federation, no. 2,326,367, July 27, 2006
  - R. V. Lapshin, *Method for automatic distributed calibration of probe microscope scanner*, Patent of Russian Federation, no. 2,295,783, January 25, 2005
  - R. V. Lapshin, *Procedure of movement of sonde of scanning microscope-nanolithograph in field of coarse X-Y positioner*, Patent of Russian Federation, no. 2,181,212, September 7, 1999
  - R. V. Lapshin, *Method for measuring surface relief by means of scanning probe type microscope*, Patent of Russian Federation, no. 2,175,761, June 8, 1999
  - R. V. Lapshin, *Method for reading digital information in probe memory device*, Patent of Russian Federation, no. 2,181,218, November 2, 1998
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### RESEARCH GRANTS

- *Synthesis and investigation of mesoscopic-scaled carbon nanostructures to form surfaces with biocompatible properties*, the Russian Foundation for Basic Research, 2005-2007
- *Application of algorithms and information methods for data readback in petabit capacity probe storage device*, the Russian Foundation for Basic Research, 2005
- *Development of low-temperature synchrotron radiation stimulated processes forming surface structures applicable to medicine*, the Moscow Committee on Science and Technologies, 2003-2004
- *Investigation of physical-chemical peculiarities of radiation-stimulated modification of surfaces of crystalline and noncrystalline solids aimed to form specific properties of the solids*, the Russian Foundation for Basic Research, 2002-2004

- *Nanotechnology development of polymer surface modification for medicine materials and manufactures*, the Moscow Committee on Science and Technologies, 2001
  - *Investigation of synchrotron light source induced chemisorption processes on semiconductor surfaces during synthesizing multilayer microstructures*, the Russian Foundation for Basic Research, 1998-2000
  - *Regular patterning of nanometer-sized metal layer on solid body surface: simulation, formation mechanisms, application to nanoelectronics*, the Russian Foundation for Basic Research, 1996-1998
  - Grant from the Fund of Physics of Solid Nanostructures, the Ministry of Science and Technologies, 1996
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## SKILLS

Sample treatment/preparation: hands-on experience in specimen treatment in glow-discharge and RF-plasma, sample thinning for high-resolution transmission electron microscopy (HRTEM)

Optical instruments: hands-on working experience with optical profiler (interference microscope) and infrared microscope (IRM)

Operation/maintenance: supervision of various low, high and ultrahigh vacuum equipment

Computer: competence in MathCAD, PCAD, programming in Pascal, C, Assembler, simple web design

Publishing: qualified for technical writing, reviewing and editing

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## MEMBERSHIP

- A fellow of the Russian Society of Scanning Probe Microscopy and Nanotechnology since 1998
  - A full member of the American Nano Society since 2011
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## SERVICES

- A referee of the Review of Scientific Instruments, the American Institute of Physics, USA
  - A referee of Measurement Science and Technology, the Institute of Physics Publishing, UK
  - A referee of Nanotechnology, the Institute of Physics, Publishing, UK
  - A referee of IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society, USA
  - An expert of the Russian Corporation of Nanotechnologies, Russian Federation
  - A supervisor of M. S. and Ph. D. students
  - A contributor to the Dictionary of Nanotechnological Terms, the Russian Corporation of Nanotechnologies, Russian Federation
  - A contributor to Encyclopedia of Nanoscience and Nanotechnology, the American Scientific Publishers, USA
  - A contributor to Wikipedia, the Free Encyclopedia
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## HONOURS AND AWARDS

- Recipient of a Medal for Inventors: *For contribution in the field of scanning probe microscopy*, the World Intellectual Property Organization (WIPO), Geneva, Switzerland, 2015
- Recipient of a diploma: *For successive inventive activity and participation in patent and licensing work*, the Chamber of Commerce and Industry of Russian Federation (CCI), Moscow, Russian Federation, 2012
- Recipient of a diploma: *For an important contribution to legal protection of subjects of intellectual property*, the Federal Service for Intellectual Property, Patents and Trademarks (Rospatent), Moscow, Russian Federation, 2012
- Recipient of 5 prestigious diplomas *100 Best Russian Inventions*, the Federal Service for Intellectual Property, Patents and Trademarks (Rospatent), Moscow, Russian Federation, 2011
- Author of 7 inventions recognized as *Perspective*, the Federal Service for Intellectual Property, Patents and Trademarks (Rospatent), Moscow, Russian Federation, 2010, 2014

- Inclusion in the international biographical directory *Who's Who in Science and Engineering*, the Marquis Who's Who LLC, New Providence, USA, 2006, 2008
  - Named among the top 20 most popular authors of Nanotechnology journal for 2004, the Institute of Physics Publishing, Bristol, England, 2005
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### EXIBITIONS

- Scientific photo exhibition *Art of Science 2014*, section *Microworld*, the artwork *Corals*, Moscow, Russian Federation, 2014
  - Scientific photo exhibition *Art of Science 2013*, section *Microworld*, the artwork *Smallfoot*, Moscow, Russian Federation, 2013
  - International festival *NanoArt 2012*, the artwork *Organ pipes*, USA, 2012
  - SPM-scan contest *ProImage 2012*, the artwork *Corals*, Zelenograd, Russian Federation, 2012
  - Scientific photo exhibition *Art of Science 2012*, section *Microworld*, the artwork *Organ pipes*, Moscow, Russian Federation, 2012
  - Scientific photo exhibition *Art of Science 2011*, section *Microworld*, the artwork *Nanodonuts*, Moscow, Russian Federation, 2011
  - Scientific photo exhibition *Art of Science 2010*, section *Microworld*, the artwork *Nanogyri of polyurethane brain*, Moscow, Russian Federation, 2010
  - Scientific photo exhibition *Science, this is beautiful!*, section *The world that is hidden from us*, the artwork *Stonework of ancient Inca*, Moscow, Russian Federation, 2009
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### EDUCATION

Term: January 2002 – December 2002

School: Institute of Physical Problems named after F. V. Lukin

Address: 5 Georgievskiy Avenue, Zelenograd, Moscow, 124460, Russian Federation

Course: Postgraduate (extension)

Specialty: Solid body electronics, radio electronic components, micro and nanoelectronics, quantum devices (no. 05.27.01)

Degree: Ph. D.

Qualification: Scientist

Major: Scanning probe microscopy and nanotechnology

Term: September 1990 – November 1993

School: "Scientific Center" Advanced Research Enterprise

Address: Zelenograd, Moscow, 103460, Russian Federation

Course: Postgraduate

Specialty: Special-purpose systems, their mathematical support and organization of computational processes (no. 05.13.15)

Qualification: Engineer-researcher

Major: Scanning tunneling microscopy

Term: September 1984 – June 1990

School: Moscow State Technical University named after N. E. Bauman

Faculty: Radio Electronics and Lasers

Department: Laser and Optoelectronic Systems

Address: 2-ya Baumanskaya St., bldg. 5, Moscow, 107005, Russian Federation

Course: Undergraduate and graduate

Specialty: Optical and optoelectronic systems (no. 19.10)

Degree: Master of science

Qualification: Optical engineer

Major: Scientific instruments

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