

CURRICULUM VITA

DR. ALEXANDER A. BALANDIN

PROFESSOR OF ELECTRICAL ENGINEERING

FOUNDING CHAIR OF MATERIALS SCIENCE AND ENGINEERING

UNIVERSITY OF CALIFORNIA – RIVERSIDE

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**Please note that the CV listings of invited talks, professional activities, extramural grants, etc. do not contain all entries and are heavily weighted toward more recent events and achievements. For complete listings, please contact the author.*

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EDUCATION AND PROFESSIONAL TRAINING

- Postdoctoral Research, University of California - Los Angeles, USA, 1997 – 1999
- Ph.D. in Electrical Engineering, University of Notre Dame, Notre Dame, USA, 1996
- M.S. in Electrical Engineering, University of Notre Dame, Notre Dame, USA, 1995
- M.S. in Applied Physics, Moscow Institute of Physics and Technology, Russia, 1991
- B.S. in Mathematics, Moscow Institute of Physics and Technology, Russia, 1989

Research Interests

Electronic, thermoelectric and optoelectronic materials and devices; nanostructures and nanodevices; Raman spectroscopy; graphene and carbon materials and devices; nanoscale phonon engineering; noise phenomena in electronic devices – *both theory and experiment*

EMPLOYMENT HISTORY

- Founding Chair (2006 – present), Materials Science & Engineering, University of California – Riverside (UCR), Riverside, California, USA
- Professor (2005 – present), Department of Electrical Engineering, University of California – Riverside (UCR), Riverside, California, USA
- Visiting Professor (2005 – 2006), Department of Engineering, University of Cambridge, Cambridge, United Kingdom
- Associate Professor (2001 – 2005) and Assistant Professor (1999 – 2001), Department of Electrical Engineering, University of California – Riverside (UCR), California, USA
- Research Engineer (1997 – 1999), Electrical Engineering Department, University of California – Los Angeles (UCLA), Los Angeles, California, USA
- Research Associate (1996 – 1997), Department of Electrical Engineering, University of Nebraska – Lincoln (UNL), Lincoln, Nebraska, USA
- Research & Teaching Assistant (1993 – 1996), Department of Electrical Engineering, University of Notre Dame (ND), Notre Dame, Indiana, USA
- Research Engineer (1991 – 1993), Moscow Institute of Physics and Technology (MIPT) and The Russian Space Agency (RSA), Moscow, Russia
- Research Assistant (1989 – 1991), Institute of Radio-Engineering and Electronics (IRE), Russian Academy of Sciences (RAS), Moscow, Russia

AWARDS AND ACADEMIC RECOGNITIONS

Selected Research and Teaching Awards and Recognitions

- Fellow of SPIE - The International Society for Optical Engineering, 2010
- Fellow of OSA - The Optical Society of America, 2010
- Distinguished Lecturer, IEEE Chapter, California, USA, 2010
- Semiconductor Research Corporation (SRC) Inventor Award, USA, 2009, 2010
- Distinguished Visiting Professor, Astrakhan State University, Russia, 2009
- Fellow of AAAS - The American Association for Advancement of Science, 2007
- Distinguished IEEE Lecturer, University of Texas, Arlington, USA, 2006
- Distinguished Lecturer, CNRS, Pierre and Marie Curie Institute, Paris, France, 2005
- Visiting Professor of Engineering, University of Cambridge, UK, 2005
- Elected Visiting Fellow, Pembroke College, University of Cambridge, UK, 2005
- Office of Naval Research (ONR) Young Investigator Award, Arlington, USA, 2002
- National Science Foundation (NSF) Faculty CAREER Award, 2001
- University of California Regents Faculty Award, USA, 2000
- US Civil Research and Development Foundation (CRDF) Award, Arlington, USA, 1999
- Merrill Lynch Innovative Engineering Research Award, WTC, New York, USA, 1998
- Who's Who in Science and Engineering, Editions 1997 – 2010
- Outstanding Teaching Assistant Award, University of Notre Dame, USA, 1996
- Elected Member, *Eta Kappa Nu* Engineering Honor Society, 1994
- Yong Scientist Award, A. Popov Radio Society Conference, Moscow, Russia, 1992
- *Summa Cum Laude*, Moscow Institute of Physics and Technology (MIPT), Russia, 1991

PLENARY LECTURES, KEYNOTE AND INVITED TALKS

Selected Plenary Lectures, Keynote and Invited Talks at International Conferences

- Invited Tutorial Talk, "Thermal conductivity of graphene: Prospects of thermal management applications," *Semi-Therm Conference*, San Jose, USA, 2011
- Invited Talk, "Electrical and noise characteristics of graphene transistors and sensors," *SPIE Smart Structures Conference*, San Diego, USA, 2011
- Invited Talk, "Thermal management applications of graphene," *3rd Symposium on Graphene, Ge/III-V, and Emerging Materials for Post-CMOS Applications*, Electrochemical Society (ECS), Vancouver, Canada, 2011
- Keynote Lecture, "Thermal properties of graphene," *Graphene 2011 Conference – Imagine Nano*, Bilbao, Spain, 2011 – the largest European event in Nanoscience and Nanotech
- Invited Talk, "Phonon engineering with graphene," *Massachusetts Institute of Technology Japan – U.S. Joint Seminar on Nanoscale Transport Phenomena (MIT-NTP)*, Tokyo, Japan, 2011

- Invited Talk, "Phonon transport in graphene materials and devices," *Symposium on Nanoscale Heat Transport – From Fundamentals to Devices*, Materials Research Society (MRS) Spring Meeting, San Francisco, California, USA, 2011
- Invited Talk, "Graphene applications in interconnects and heat spreaders," *International Conference on Solid State Devices and Materials (SSDM)*, The University of Tokyo, Tokyo, Japan, 2010
- Keynote Lecture, "Phonon engineering: From nanowires and quantum dots to graphene and topological insulators," *ICREA Workshop on Phonon Engineering*, St Feliux de Guixol, Barcelona, Spain, 2010
- Invited Talk, "Graphene-like" exfoliation of atomically-thin films of Bi₂Te₃ and related materials: Applications in thermoelectrics and topological Insulators," *Symposium on Compound Semiconductors*, Electrochemical Society (ECS), Las Vegas, USA, 2010
- Invited Talk, "New carbon materials for thermal management," *SRC Carbon Based Electronics Workshop*, University of Albany – SUNY, Albany, New York, USA, 2010
- Keynote Lecture, "Thermal conductivity of graphene and carbon materials," *International Workshop on Nanocarbon Photonics and Optoelectronics (NPO)* North Karelia, Finland, 2010
- Invited Talk, "Extraordinary thermal conductivity of graphene: Applications in thermal management," *2nd Symposium on Graphene, Ge/III-V, and Emerging Materials for Post-CMOS Applications*, Electrochemical Society (ECS), Vancouver, Canada, 2010
- Invited "Upgraded" Talk, "Properties of mechanically exfoliated atomically-thin films of bismuth telluride," *Conference on the Physics and Chemistry of Surfaces and Interfaces (PCSI)*, Santa Fe, New Mexico, USA, 2010
- Invited "Session Opening" Talk, "Phonon transport in graphene," Session on Thermal Properties of Graphene, *Symposium on Graphene Materials and Devices*, Materials Research Society (MRS) Spring Meeting, San Francisco, California, USA, 2010
- Invited Lecture on Nanotechnology, "New materials for thermal management," *The Applied Power Electronics Conference and Exposition (APEC) and Inaugural Public Nanotechnology Initiative*, Palm Springs, California, USA, 2010
- Keynote Lecture, "Graphene properties and possible micro- and nano-device applications," *NATO Advanced Research Workshop (ARW) on Advanced Materials and Technologies for Micro/Nano-Devices, Sensors and Actuators*, St. Petersburg, Russia, 2009
- Keynote "Opening" Lecture, "Thermal conductivity of graphene," Joint Session of *The Joint 30th International Thermal Conductivity Conference (ITCC)* and *The 18th International Thermal Expansion Symposium (ITES)*, Seven Springs Mountain Resort, Pennsylvania, USA, 2009
- Plenary Lecture, "Thermal conductivity of graphene," *9th Biennial International Conference on Fullerenes and Atomic Clusters*, The Russian Academy of Sciences (RAS) and The Russian Foundation for Basic Research (RFBR), St. Petersburg, Russia, 2009
- Invited "Session Opening" Talk, "Phonon engineering with graphene and graphene multi-layers," Session on Phonon Transport in Nanostructures, *Symposium on Phonon Engineering for Enhanced Materials Solutions*, Materials Research Society (MRS) Fall Meeting, Boston, Massachusetts, USA, 2009
- Invited Lecture, "Thermal conductivity of graphene," *The Graphene Week Conference*, The European Science Foundation (ESF), Obergurgl, Austria, 2009

- Keynote “Opening” Lecture, “Graphene properties and possible device applications,” *The International Symposium on Graphene Devices: Technology, Physics, and Modeling (ISGD)*, Aizu-Wakamatsu, Japan, 2008
- Keynote Talk, “Development of the high-efficiency nanostructure-based solar cells,” *UC-Riverside – Tohoku University Tech Horizons Conference*, Riverside, California, USA, 2008
- Invited “Symposium Opening” Talk, “Nanoscale phonon engineering: From nanowire transistors to graphene devices,” *Symposium on Phonon Engineering - Theory and Applications*, Materials Research Society (MRS) Fall Meeting, Boston, Massachusetts, USA, 2007
- Invited Talk, “Extremely high thermal conductivity of graphene,” *Zing Nanomaterials Conference*, Playa del Carmen, Cancun, Mexico, 2008
- Keynote Lecture, “Carrier transport in quantum dot superlattices: Applications in solar cells and thermoelectric,” *The Aerospace Corporation – NASA Space Power Workshop (SPW)*, Los Angeles, California, USA, 2007
- Invited Talk, “Phonons in semiconductor quantum dot materials,” *Symposium on Quantum Dot Physics and Materials*, The International Society for Optical Engineers (SPIE) *Optoelectronics: Quantum Dots and Nanoclusters*, San Jose, California, USA, 2007
- Invited Talk, “Optimization of electron and phonon transport in quantum dot superlattices for thermoelectric applications,” *The 2nd International Energy Nanotechnology Conference*, American Society of Mechanical Engineers (ASME), Santa Clara, California, USA, 2007
- Invited Talk, “Phonon engineering in nanowires with the acoustically mismatched barrier shells,” *Symposium on Nanoscale Heat Transport - From Fundamentals to Devices*, Materials Research Society (MRS) Spring Meeting, San Francisco, California, USA, 2007
- Invited Talk, “Phonons and phonon engineering in nanostructures: From nanowire transistors to graphene devices,” *Virtual Conference on Nanoscale Science and Technology (VC-NST)*, Fayetteville, Arkansas, USA, 2007
- Invited Talk, “Modeling-based optimization of the quantum dot solar cells,” *UC-Riverside Tech Horizons Conference*, Riverside, California, USA, 2007
- Keynote Lecture, “Solar cell nanotechnology for improved efficiency and radiation hardness,” *Symposium on Photonics for Space Environments*, The International Society for Optical Engineering (SPIE), San Diego, California, USA, 2006
- Invited Talk, “Phonon engineering in semiconductor nanowires and quantum dot superlattices,” *Workshop on Nano-Technology and Information for Space Applications*, The 2nd IEEE – NASA International Conference on Space Mission Challenges for Information Technology, Pasadena, California, USA, 2006
- Invited Talk, “Phonons in Si nanowires and Si/SiGe quantum dot superlattices,” *IEEE Silicon Nanoelectronics Workshop*, Honolulu, Hawaii, USA, 2006
- Keynote Lecture, “Phonon engineering in nano-devices and virus-based nano-templates,” *Symposium on Noise and Information in Nanoelectronics, Sensors and Standards*, The International Society for Optical Engineering (SPIE), Austin, Texas, USA, 2005
- Plenary Lecture, *International Conference on Phonon Scattering in Condensed Matter Physics – The 11th PHONONS Conference*, St. Petersburg, Russia, 2004

- Invited Talk, "Computational modeling of electron - phonon spectra in semiconductor quantum dot arrays," *The 3rd International Conference on Computational Modeling and Simulation of Materials (SIMTEC)*, Acireale, Sicily, Italy, 2004
- Invited Talk, "Carrier and phonon spectrum in quantum dot superlattices for optoelectronic and thermoelectric applications," *Nanotechnology Conference and Trade Show (NanoTech)*, San Francisco, California, USA, 2003
- Plenary Lecture, "Investigation of low-frequency noise in heterostructure field-effect transistors based on wide band gap semiconductors," *The 16th International Conference on Noise in Physical Systems and 1/f Fluctuations (ICNF)*, Gainesville, Florida, USA, 2001
- Plenary Talk, "1/f Noise in GaN devices," *The 7th Van der Ziel Symposium on Quantum 1/f Noise and Other Low Frequency Fluctuations in Electronic Devices*, American Institute of Physics (AIP) Conference Series, St. Louis, Missouri, USA, 1999

Selected Distinguished Lectures and Invited Talks at University Colloquia and Seminars

- Invited Colloquium Speaker, "Properties and applications of graphene," Physical Chemistry Colloquium, *California Institute of Technology*, Pasadena, California, USA, 2010
- Distinguished Lecturer, "Overview of carbon materials and their properties: From diamond to graphene," *Astrakhan State University (ASU)*, Astrakhan, Russia, 2010
- Invited Colloquium Speaker, "Two-dimensional phonon transport in graphene," *Helsinki University of Technology (HUT)*, Helsinki, Finland, 2009
- Invited Colloquium Speaker, "Raman nanometrology of graphene", Department of Materials Science and Engineering, *UCLA*, Los Angeles, California, USA, 2008
- Invited Speaker, "Nanostructured solar cells," Department of Materials Science, *Tohoku University*, Sendai, Japan, 2007
- Invited Colloquium Speaker, "Semiconductor nanostructures: Properties and applications for the direct energy conversion," Department of Mechanical Engineering, *University of California – Riverside (UCR)*, California, 2007
- Invited Speaker, "Properties of semiconductor quantum dot superlattices," Department of Semiconductor Physics, *Moscow State University (MSU)*, Moscow, Russia, 2006
- Distinguished Lecturer, "Nanoscale phonon engineering: From concepts to devices applications," *University of Texas – Arlington (UTA)*, Texas, USA, 2006
- Distinguished Lecturer, "Nanoscale phonon engineering: Fundamentals and applications," *Prokhorov's General Physics Institute of the Russian Academy of Sciences*, Moscow, Russia, 2006
- Invited Colloquium Speaker, "GaN materials and devices: Traps, noise and heat," Department of Engineering, *University of Cambridge*, Cambridge, UK, 2005
- Distinguished Lecturer, "Phonon engineering at nanoscale," *Pierre and Marie Curie Institute, CNRS*, Paris, France, 2005
- Invited Colloquium Speaker, "Phonon engineering in acoustically mismatched nanowires," Department of Physics, *University of Southern California (USC)*, Los Angeles, California, 2005
- Invited Colloquium Speaker, "Phonon engineering in nanoscale devices," Department of Electrical Engineering, *University of California – San Diego (UCSD)*, California, 2004

- Invited Colloquium Speaker, “Phonon engineering: Physics and applications,” Department of Physics, *University of California – Irvine* (UCI), Irvine, California, 2004
- Invited Colloquium Speaker, “Low-frequency noise in GaN HFETs,” Department of Electrical Engineering, *University of Texas – Austin* (UTA), Austin, Texas, 1999

Selected Invited Talks at Government Organizations and Industry

- Invited Speaker, “Graphene-like” exfoliated topological insulators: Optical, electrical and thermal characterization,” *DARPA Workshop on Topological Insulators*, UCLA, Los Angeles, California, USA, 2010
- Invited Speaker, “Graphene heat spreaders and composite substrates for improved thermal management,” *Interconnect Focus Center (IFC) Seminar Series*, Semiconductor Research Corporation (SRC) and Georgia Institute of Technology, Atlanta, Georgia, 2010
- Invited Speaker, “Phonon and thermal nanoengineering,” *SRC – DARPA Functional Engineered Nano Architectonics Workshop*, Los Angeles, California, USA, 2010
- Invited Speaker, “Overview of DoD funded solar power activities in Nano-Device Laboratory,” *South California Research Institute for Solar Energy (SC-RISE) Solar Summit*, University of California – Riverside (UCR), Riverside, California, USA, 2010
- Invited Speaker, “Phonon engineering: Innovative approaches for the electron mobility enhancement at nanoscale,” *AFOSSR Joint Electronics Program Review and Workshop*, US Air Force Office of Scientific Research (AFOSSR), Arlington, Virginia, USA, 2009
- Invited Speaker, “Highlights of graphene electronics research,” *Intel – SRC – DARPA Advanced Electronics Workshop*, Intel Corporation, Portland, Oregon, 2008
- Invited Lecturer, “Overview of carbon materials: From diamond to graphene,” *California Clean Energy Initiative Seminar Series*, California Institute of Nanotechnology, San Bernardino, California, USA, 2008
- Invited Speaker, “Carbon materials for thermal management,” *SRC – DARPA Functional Engineered Nano Architectonics Workshop*, San Diego, California, 2008
- Invited Speaker, “Acoustic phonon engineering in semiconductor nanostructures,” *DARPA Workshop on Nanoscale Phonon Engineering (NOPE)*, Arlington, Virginia, USA 2005
- Invited Speaker, “Phonon engineering: From concept to device applications,” *NSF Workshop on Silicon Nanoelectronics and Beyond*, Arlington, Virginia, USA 2005
- Invited Speaker, “Micro-Raman characterization of stress/strain in semiconductors,” *Raytheon Vision Systems (RVS)*, Goleta, California, USA, 2005
- Invited Speaker, “Nanoscale phonon engineering,” *Superconducting Electronics Workshop and Program Review*, Office of Naval Research (ONR), Red Bank, New Jersey, USA, 2005
- Invited Lecturer, “Nanophononics: Concept and device applications,” *California Nanosystems Institute (CNSI)*, UCLA, Los Angeles, California, USA, 2005
- Invited Speaker, “Thermal conductivity of AlGaN materials: Implications for high-power electronics,” *NASA Jet Propulsion Laboratory (JPL)*, Pasadena, California, USA, 2004
- Invited Speaker, “Thermal properties of GaN films and AlGaN alloys,” *Office of Naval Research Workshop on Advanced Materials*, Tampa, Florida, USA, 2004

- Invited Speaker, “Phonon engineering for enhancement of device operation,” *Workshop on Novel Device Concepts*, Semiconductor Research Corporation (SRC) the Naval Postgraduate School, Monterey, California, USA, 2003
- Invited Speaker, “Phonon confinement effects in semiconductor nanowires,” *Ames Research Center*, National Aeronautics and Space Administration (NASA), Moffett Field, California, USA, 2002

AWARD RECEIVED BY MY STUDENTS OR GROUP MEMBERS

Research Awards Received by PhD Students under my Supervision

- Samia Subrina, *The 2nd Place Award in the International Research Poster Competition* for “Thermal management of 3D electronics with graphene heat spreaders,” *Society of Women Engineers (SWE)*, Tampa, Florida, USA, 2010 (co-authored with A.A. Balandin)
- Guanxiong Liu, *The Best Student Research Presentation Award* for “Electronic noise in graphene transistors,” *Advanced Workshop on Frontiers in Electronics (WOFE)*, Rincon, Puerto Rico, 2009 (co-authored with A.A. Balandin)
- Desalegne Teweldebrhan, *UCR Alliance for Graduate Education and Professoriate Award* to report “Irradiated graphene,” *Graphene Week*, College Park, Maryland, USA, 2009
- Suchismita Ghosh, *The Inventor Recognition Award* for “Graphene lateral heat spreaders,” *TECHCON Conference*, Austin, Texas, USA, 2009 (co-authored with A.A. Balandin)
- Javed Khan and Craig Nolen, *The 2nd Place Award in the Graduate Student Competition* for “Wireless sensor networks with graphene-based rechargeable power sources,” *IEEE EDS Meeting at UC Riverside*, California, 2009 (Judges: EDS Presidents C. Claeys and R. Jindal)
- Samia Subrina, *The 3rd Place Award in the International Research Poster Competition* for “Thermal management of electronics with graphene heat spreaders,” *Society of Women Engineers (SWE)*, Long Beach, California, USA, 2009 (co-authored with A.A. Balandin)
- Vivek Goyal, *The Best Research Poster Award* for “Heat propagation in graphene: Theory and experiment,” *DARPA –SRC Workshop and Review*, Los Angeles, California, USA, 2009 (co-authored with A.A. Balandin) – selected from ~ 50 entries from the top US universities
- Suchismita Ghosh, *The 2nd Place Award in the International Research Poster Competition* for “Giant thermal conductivity of graphene: Thermal management applications,” *Society of Women Engineers (SWE)*, Baltimore, Maryland, USA, 2008 (co-authored with A.A. Balandin)
- Irene Calizo, *Graduate Dean Dissertation Fellowship Award* for her PhD dissertation “Raman nanometrology of graphene,” UC Riverside, California, USA, 2008
- Irene Calizo, *The 2nd Place Award in the International Research Poster Competition* for “Robust micro-Raman identification of the atomic layers of graphene,” *Society of Women Engineers (SWE)*, Nashville, Tennessee, USA, 2008 (co-authored with A.A. Balandin)
- Manu Shamsa, *The Best Student Paper Award – MRS Silver Medal* for the paper “Thermal conductivity of nanocrystalline diamond films,” *Materials Research Society (MRS)*, San Francisco, California, USA, 2007 (co-authored with A.A. Balandin)

- Manu Shamsa, *IBM International Dissertation Fellowship Award*, IBM T.J. Watson Research Center, Yorktown Heights, New York, USA, 2007 - 2009
- Manu Shamsa and Khan Alim, *The 3rd Place Award in the Best Research Competition* for the presentation "Functionalized nanostructures with the negative differential resistance," *DARPA –SRC Workshop and Review*, Los Angeles, California, USA, 2006 (co-authored with A.A. Balandin) – selected from ~ 50 entries from the top US universities
- Manu Shamsa, *The Best Research Poster Award* for the paper "Modeling of thermal conduction mechanisms in the amorphous inter-layer dielectrics," *Materials Research Society (MRS)*, San Francisco, California, USA, 2006 (co-authored with Intel engineers)
- Khan Alim and Mayank Varshney, *The 2nd Place Award in the Best Research Competition* for the presentation "New approaches for heat removal from beyond-CMOS nanoelectronic circuits," *DARPA –SRC Workshop and Review*, Los Angeles, California, USA, 2005 (co-authored with A.A. Balandin) – selected from ~ 50 entries from the top US universities
- Jie Zou, *The Best Student Paper Award – MRS Silver Medal* for the paper "The lattice thermal conductivity in semiconductor nanowires," *Materials Research Society (MRS)*, San Francisco, California, USA, 2002 (co-authored with A.A. Balandin)
- Jie Zou, *The 1st Place Award in the Best Research Poster Competition* for the presentation "Optimization of heat removal from nanoscale devices," *The First BCOE Industry Day*, Riverside, California, USA, 2001 (co-authored with A.A. Balandin)

Research Awards Received by Postdoctoral Researchers under my Supervision

- Dr. Denis Nika, *Presidential Best Young Scientist Award of the Republic of Moldova*, 2009. This award is presented by the country's president to the best young scientist, selected among all citizens of Moldova who work in natural sciences or technical disciplines. The award was given to Dr. Nika for the papers co-authored with Prof. Balandin in 2008 – 2009.
- Dr. Vladimir Fonoberov, *The Best Theory Paper – Young Scientist Award* for the paper "Interface phenomena in wurtzite and zincblende GaN/AlN quantum dots and their effect on optical properties," *Conference on the Physics and Chemistry of Semiconductor Interfaces (PCSI - 31)*, Kailua-Kona, Hawaii, USA, 2004 (co-authored with A.A. Balandin)
- Dr. Vladimir Fonoberov, *NSF – NATO Postdoctoral Researcher Fellowship Award* in Condensed Matter Physics, 2004 – 2006 (project co-authored with A.A. Balandin)
- Dr. Olga Lazarenkova, *The Best Paper Award in the Theory and Modeling Session* for the paper "3D mini-band formation in semiconductor quantum dot crystals," *Materials Research Society (MRS)*, San Francisco, California, USA, 2001 (co-authored with A.A. Balandin)

MEDIA COVERAGE OF RESEARCH ACHIEVEMENTS

- A chapter in the book *Nano-Society: Pushing and Boundaries of Technology* (Royal Society of Chemistry, RSC Publishing, London, UK, 2010) about the most notable achievements in nanotechnology world-wide was dedicated to the discovery of the extraordinary thermal

properties of graphene made in Balandin laboratory at UCR (see section “Amazing New Materials” on page 95). The book is written by the UK-based technology expert M. Berger.

- The graphene research conducted in Professor Balandin’s Nano-Device Laboratory (NDL) research group at UCR was the subject of an episode of *The Loh Down on Science*, the *nationally syndicated* radio program featuring Sandra T. Loh and broadcast locally on KPCC, the *National Public Radio* affiliate in Pasadena (summer 2010).
- The first demonstration of the triple-mode graphene amplifier conducted in Balandin lab, in collaboration with Rice University researchers, was highlighted in *MIT Technology Review*, *Materials Today*, *Physics World*, *Optics and Photonic News (OPN)*, *NanotechWeb*, *NanoWerk*, *Gizmag*, *Softpedia*, and other publications as well as by the UC Riverside and Rice University media.
- Professor Balandin and his group members became the few selected for the new UCR public relations campaign *Living the Promise*. An episode of the movie was shot in NDL. It featured the discovery of graphene’s unusual thermal conductivity properties. Professor Balandin and his graduate students were also featured in the special UCR publication *Living the Promise* and web-site (2010).
- The first mechanical exfoliations of individual quintuples – atomically thin layers – of *topological insulators* performed in Balandin group at UCR was featured on the cover of the *Applied Physics Letters* (v. 96, 2010)) and highlighted in *Nature* journal. The news section’s story was entitled *Condensed matter: Cutting it fine* (*Nature*, 463, 852-853, 2010). *Nature* has the highest impact factor of all journals in sciences and engineering.
- *IEEE Spectrum* (the main publication of the largest engineering professional society – IEEE) highlighted Balandin group’s research on the inside cover of its October 2009 issue. It also featured an invited full-length review paper about the discovery of graphene’s superior thermal conductivity and possible new materials for thermal management of future ICs.
- The first demonstration of the top-gate graphene transistors with the low level of electronic noise accomplished at NDL was highlighted in *Nature Nanotechnology* in the Research Highlights section, entitled *Graphene transistors: Noisy gate* (*Nature Nanotechnology*, 2009).
- The first experimental demonstration of the thermal transport evolution between 2D and 3D systems carried out in Balandin laboratory and reported in *Nature Materials* (2010) attracted a world-wide attention and was covered by more than 50 media outlets in different languages (English language examples include *Discovery*, *CNET News*, *Physics World*, *Investor Spot*).
- The first report of graphene properties’ change under e-beam irradiation reported in *Applied Physics Letters* (2009) was highlighted in *NanoWerk* and *DARPA-SRC Newsletter*.

- Professor Balandin's work on phonon engineering and thermal transport in graphene was highlighted in *Physics World* and *PhysOrg.com* - UK- based news media (2006 – 2008)
- The NDJ research featured on the front-page of the *SYNOPSIS University Newsletter* (2007)
- *The Energy Notes* (v. 3, issue 4, page 4), a publication of the *California Energy Institute*, wrote about thermoelectric research in Balandin research group at UCR.
- The Balandin research group was highlighted in the UC Office of the President (UCOP) publication on NSF funded research in UC system. The feature *Exploring the World at Nanoscale* stated "At UC Riverside, a group of young researchers is gaining recognition for its pioneering work in nanotechnology." (2001).

TEACHING AND GRADUATE STUDENT SUPERVISION

Curriculum Development and Courses Taught in the University of California

- As the *first* EE Department's hire in the broadly defined area of *Materials and Devices*, I developed the *first* courses and study plans for both undergraduate and graduate students specializing in *Nano Materials, Devices and Circuits* (NMDC). Now NMDC is the most active area of research and education at the Department of Electrical Engineering featuring more than 30 graduate – level courses alone.
- As the *Founding Chair* of the campus-wide *Materials Science and Engineering* (MS&E) Interdisciplinary Program at UCR, I led curriculum development, introduced the *first* MS&E courses, and helped with a number of materials courses at participating departments.
- I taught the following undergraduate courses
 - *EE116 Engineering Electromagnetics – I* (required for all EE majors; taught 7 years)
 - *EE117 Engineering Electromagnetics – II* (developed laboratory for this course)
 - *EE107 Solid-State Electronics* (offered this course for the first time at UCR)
 - *EE133 Solid-State Electronics* (developed and taught this course instead of EE107)
 - *EE175 Senior Design Project* (made major contributions to its development)
- I taught the following graduate courses
 - *EE202 Fundamentals of Semiconductor Materials and Nanostructures* (developed this core course and offered it for the first time; taught it each year since 2000)
 - *EE207 Noise in Electronic Materials and Devices* (developed and taught this advanced graduate course to cover gaps in education pertinent to measurements)
 - *EE216 Nanoscale Phonon Engineering* (developed and taught advanced graduate course required for research)

- *EE259 Colloquium in Electrical Engineering* (colloquium organization)
- *EE290 Directed Studies; EE297 Dissertation Research; EE299 Research for Thesis*

Recently Graduated PhD Students under my Supervision and their Current Jobs

- Dr. Suchismita Ghosh (PhD, UCR, 2010); Dissertation: “Thermal conduction in graphene and graphene multi-layers,” current job: R&D Engineer, *Intel Corporation*, Portland, Oregon, USA
- Dr. Muhammad Rahman (PhD, UCR, 2010); Dissertation: “Fabrication and characterization of nanowire transistors with enhanced performance,” current job: Research Engineer, *Lawrence Berkeley National Laboratory (LBNL)*
- Dr. Samia Sabrina (PhD, UCR, 2010); Dissertation: “Modeling of thermal transport in graphene devices,” current job: Research Associate, *UC-Riverside*, USA
- Dr. Irene Calizo (PhD, UCR, 2009); Dissertation: “Raman nanometrology of graphene,” current job: Researcher, *National Institute of Standards and Technology (NIST)*, Gaithersburg, Maryland, USA
- Dr. Qinghui Shao (PhD, UCR, 2009); Dissertation: “Optimized design and materials for nanostructure based solar cells,” Research Engineer, *Lawrence Livermore National Laboratory (LLNL)*, Livermore, California, USA
- Dr. Manu Shamsa (PhD, UCR, 2007); Dissertation: “Thermal transport in advanced engineered materials” current job: R&D Engineer, *Intel Corporation*, Portland, Oregon, USA
- Dr. Khan A. Alim (PhD, UCR, 2006); Dissertation: “Raman characterization of hybrid bio-inorganic nanostructures,” current job: Engineer, *POC*, Torrance, California, USA
- Dr. Y. Bao (PhD, UCR, 2005); Dissertation: “Electrical characterization and applications of quantum dot superlattices,” current job: Lead Engineer, *Semiconductor Industry*, China
- Dr. J. Zou (PhD, UCR, 2002), Dissertation: “Thermal conduction in silicon nanowires and gallium nitride films,” current job: Associate Professor, *East Illinois University*, Illinois, USA

Supervised Postdoctoral Researchers and their Current Positions

- Dr. D.L. Nika (Postdoctoral, 2006 – 2010); current job: Associate Professor, Department of Physics, *Moldova State University*, Chisinau, Republic of Moldova
- Dr. I. Bejenari (Fulbright Scholar, 2008 – 2009); current job: Research Associate, Technical University of Moldova, Chisinau, Republic of Moldova
- Dr. W.L. Liu (Postdoctoral, 2003 – 2006); current job: Lead Engineer, *Touch Down Technology*, Los Angeles, California, USA
- Dr. V. Fonoberov (Postdoctoral, 2002 – 2006); current job: R&D Leader, *Aimdyn, Inc.*, Santa Barbara, California, USA
- Dr. V.O. Turin (Postdoctoral, 2003 – 2005); current job: Professor, Department of Electronics and Systems, *Orel State Technological University*, Orel, Russia
- Dr. S. Dmitriev (Visiting, 2003); current job: Assistant Professor, Laboratory of Low-Dimensional Structures, *Moldova State University*, Chisinau, Republic of Moldova

- Dr. O. Lazarenkova (Postdoctoral, 2001 – 2003); current job: Research Engineer, *NASA Jet Propulsion Laboratory*, Pasadena, California, USA

Recently Graduated MS Students with Thesis under my Supervision and their Current Jobs

- Mr. Pradyumna Goli (MS, UCR, 2008); current job: GSR, UC-Riverside, California
- Mr. Farough Parvizi (MS, UCR, 2008); current job: High-Tech, Irvine, California
- Ms. Suma Raj (MS, UCR, 2008); current job: Researcher, Oklahoma University
- Mr. Y.A. Tan (MS, UCR 2007); current job: High-Tech, San Jose, California
- Mr. M. Varshney (MS, UCR 2005); current job: Engineer, MoSys, Inc., San Jose
- Dr. D. Kotchetkov (MS, UCR 2003), current job: Engineer, Brookhaven National Laboratory
- Mr. X. Yao (MS, UCR 2002); current job: Engineer, Quick Logic Corp, San Jose

Currently Supervised PhD Graduate Students Supported through my Research Grants

- Mr. Desalegne Teweldebrhan (PhD candidate in EE), domestic, BS in Physics, UCR
- Javed Khan (PhD candidate in EE), domestic, BS in EE, UCR
- Guanxiong Liu (PhD candidate in EE), international, BS in EE, Beijing Univ., China
- Muhhamad Rahman (PhD candidate in EE), international, MS in EE, Univ. of Florida
- Pradyumna Goli (PhD student in MS&E), international, BS in EE, Nehru University, India
- Vivek Goyal (PhD candidate in EE), international, BS in EE, Kangri University, India
- Jie Yu (PhD candidate in EE), international, BS in EE, Univ. Science & Technology, China
- Craig Nolen (PhD candidate in EE), domestic, BS in EE, UC Riverside
- Zahid Hossain (PhD candidate in EE), international, BS in EE, BUET, Bangladesh
- Khan Farhan Shahil (PhD candidate in EE), international, BS in EE, BUET, Bangladesh
- Zhong Yan (PhD candidate in EE), international, MS in EE, Nanjing University, China

Service in PhD Dissertation and MS Thesis Committees for other UCR Students

- Served as Member of PhD Dissertation Committees for more than 40 graduate students
- Served as Member of MS Thesis Committees for more 15 students

Service in Dissertation, Examination and Related Committees outside UC System

- X. Yang, PhD in Electrical Engineering, Rice University, USA, 2010
- A.S. Askerov, PhD in Physics, Moldova State University, Republic of Moldova, 2010
- D.L. Nika, PhD in Physics, Moldova State University, Republic of Moldova, 2007
- V.A. Fonoberov, PhD in Physics, Moldova State University, Republic of Moldova, 2004

Recent Internships of UC-Riverside PhD Students under my Research Supervision

- Guanxiong Liu, *IBM T.J. Watson Research Center*, Yorktown Heights, New York, USA, 2010
- Muhammad Rahman, *IMEC*, Leuven, Belgium, 2010

- Pradyumna Goli, CFD Research Corporation, Huntsville, Alabama, USA, 2010
- Javed Khan, NASA Jet Propulsion Laboratory, Pasadena, California, USA, 2009
- Suchismita Ghosh, *Intel Corporation*, Portland, Oregon, USA, 2008
- Irene Calizo, *Lawrence Livermore National Laboratory (LLNL)*, California, USA, 2008
- Manu Shamsa, *IBM T.J. Watson Research Center*, Yorktown Heights, New York, USA, 2006
- Manu Shamsa, *Intel Corporation*, Portland, Oregon, USA, 2006

PROFESSIONAL SERVICE

Highlights of Honorary Invited Service at International Conferences

- Symposium Chair (with A. Geim, U. Manchester and J. Huang, Northwestern U.), *Symposium on Functional Two-Dimensional Materials*, Materials Research Society (MRS), San Francisco, California, USA, 2011
- Invited Panelist, Panel on Graphene vs. Silicon, *International Conference on Solid State Devices and Materials (SSDM)*, The University of Tokyo, Tokyo, Japan, 2010
- Session Chair, Electrical Properties of Graphene, *Symposium on Graphene Materials and Devices*, Materials Research Society (MRS), San Francisco, California, USA, 2010
- Session Chair, Electromagnetic Properties of Carbon Materials, *International Workshop on Nanocarbon Photonics and Optoelectronics (NPO)*, Koli, North Karelia, Finland, 2010
- Session Chair (with K. Jenkins, IBM), Spectroscopic Studies of Graphene, *Symposium on Graphene, Ge/III-V, and Emerging Materials for Post-CMOS Applications*, Electrochemical Society (ECS), Vancouver, Canada, 2010
- Symposium Chair (with P.K. Schelling, U. Florida), *Symposium on Nanoscale Heat Transport - From Fundamentals to Devices*, Materials Research Society (MRS), San Francisco, California, USA, 2009
- Session Chair, Carbon Applications, *9th Biennial International Conference on Fullerenes and Atomic Clusters (IWFAC)*, St. Petersburg, Russia, 2009
- Invited Panelist, Panel on Graphene Applications, *The International Symposium on Graphene Devices: Technology, Physics, and Modeling (ISGD)*, Aizu-Wakamatsu, Japan, 2008
- Member, International Advisory Committee, *4th International Conference on Materials Science and Condensed Matter Physics (MSCMP)*, Chisinau, Republic of Moldova, 2008
- Session Chair, Quantum Dot Physics and Materials, *Optoelectronics Symposium: Quantum Dots, Particles and Nanoclusters*, SPIE, San Jose, California, USA, 2007
- Member, International Advisory Committee, *5th International Conference on Microelectronics and Computer Science (ICMCS)*, Chisinau, Republic of Moldova, 2007
- Invited Panelist, Panel on Future Nanoelectronics, *Workshop on Silicon Nanoelectronics and Beyond*, National Science Foundation (NSF), Arlington, Virginia, USA 2005
- Member, Program Committee, The SPIE International Symposium on Fluctuations and Noise, Austin, Texas, 2005 and Florence, Italy, 2006
- Conference Chair, *Conference on 1/f Noise and Fluctuations in Electronic Devices*, The International Society for Optical Engineering (SPIE), Austin, Texas, USA, 2005

- Member, Program Committee, *The 2nd Conference on Nanoscale Devices and System Integration* (CNDSI), Houston, Texas, USA, 2005
- Session Chair, International Symposium on Nanoscale Devices and Materials, *Joint International Meeting of the Electrochemical Society* (ECS), Honolulu, Hawaii, USA, 2004
- Session Chair, Noise in GaN Devices, *Symposium on 1/f Noise in Electronic Devices*, The International Society for Optical Engineering (SPIE), Canary Islands, Spain, 2004
- Member, Program Committee, *Symposium on Fluctuations and Noise*, The International Society for Optical Engineering (SPIE), Santa Fe, New Mexico, 2003
- Session Chair (with E. Yablonovitch, UC-Berkeley), *International Symposium on Quantum Confinement*, Electrochemical Society (ECS), San Francisco, California, USA, 2001
- Member, Program Committee, *Van der Ziel Symposium on 1/f Noise in Electronic Devices*, St. Louis, Missouri, 2000
- Session Chair, Quantum Devices, *International Symposium on Quantum Confinement*, Electrochemical Society (ECS), Honolulu, Hawaii, USA, 1999

Invited Editorial Service for Technical Journals

- Editor-in-Chief, *Journal of Nanoelectronics and Optoelectronics* (JNO), 2005 – present
- Associate Editor, *IEEE Transactions on Nanotechnology* (TNANO), 2008 – present
- Editorial Board Member, *Journal of Nanoscience Letters* (JNL), 2010 – present
- Editorial Board Member, *Journal of Nanoscience and Nanotechnology* (JNN), 2001 – present
- Advisory Board Member, *Moldavian Journal of Physical Sciences* (MJPS), 2001 – present
- Co-Editor of the *Special Issue on THz Techniques and Applications*, JNO, 2005
- Guest Editor for the *Physics of Low – Dimensional Structures* (PLDS), 2002

Invited Editorial Service for Technical Book Publishers

- Editor (with K.L. Wang, UCLA), *Handbook of Semiconductor Nanostructures and Nanodevices* (ASP, Los Angeles, 2006), volumes: (1) Self-Assemblies, Quantum Dots, and Nanowires; (2) Nanofabrication and Nanoscale Characterization; (3) Spintronics and Nanoelectronics; (4) Nanophotonics and Optoelectronics; (5) Nanodevices and Circuits
- Editor, *Noise and Fluctuations Control in Electronic Devices* (ASP, Los Angeles, 2002)
- Member, Advisory Board, *Advances in Nanotechnology* (ASP, Los Angeles), 2000 – present
- Editor (with M. Jamal Dean, McMaster U.), *Noise in Devices and Circuits III*, Proceedings of SPIE, Vol. 5844, 2005
- Reviewer, *Engineering Electromagnetics* textbooks (undergraduate and graduate level) published by McGraw-Hill, Wiley, Oxford University Press and Prentice Hall, 2003 – 2008

Highlights of the Reviewer Professional Service for Technical Journals

Nature, Nature Nanotechnology, Nature Materials, Nano Letters, Applied Physics Letters; Journal of Applied Physics; IEEE Transaction on Electronic Devices; IEEE Photonics Technology Letters; IEEE Electron Device Letters; IEEE Transactions on Nanotechnology; IEEE

Transactions on Microwave Theory and Techniques; Optics and Photonics Letters; Physical Review B; Physical Review Letters; MRS Journal of Nitride Semiconductor Research; Journal of Nanoelectronics and Optoelectronics; Fluctuations and Noise Letters; Journal of Raman Spectroscopy; ACS Nano; Journal of Nanoscience and Nanotechnology; ASME Journal of Heat Transfer; Journal of Superlattices and Microstructures; Chemical Physics Letters; Journal of Chemical Physics; Optics Letters; Journal of Physics: Condensed Matter; Journal of Materials Research, Journal of Materials Science, European Journal of Physics, European Physics Letter, *physica status solidi*, etc.

Professional Reviewer Service for Funding Agencies

- US National Science Foundation (NSF)
- US Civil Research & Development Foundation (CRDF)
- US Department of Defense (DoD)
 - US Army Research Office (ARO)
 - US Office of Naval research (ONR)
 - US Air Force Office of Scientific Research (AFOSR)
- US Department of Energy (DoE)
- US National Aeronautics and Space Administration (NASA)
- US Civil Research and Development Foundation (CRDF)
- National Research Council Canada (NRC)
- United States – Israel Binational Science Foundation (BSF)
- European Science Foundation (ESF)
- International Foundation for Science – European Union (IFS)
- National Research Foundation of Korea (NRFK)
- University of California MICRO Program
- University of California SMART Program

Membership and Service in Professional Societies

- Member, Materials Research Society (MRS)
Activities: organized several MRS symposia; served as a chair for symposium sessions; gave four invited talks at the Spring (San Francisco) and Fall (Boston) meetings.
- Fellow, Optical Society of America (OSA)
Activities: organized and currently serve as faculty advisor for OSA student chapter at UCR; created the first optics relevant courses at BCOE and included UCR into the SPIE-OSA Optics and Photonics Education Directory.
- Fellow, The International Society for Optical Engineering (SPIE)
Activities: served as a conference chair, member of the conference program committees and chair of the conference sessions; gave several keynote and invited talks.
- Fellow, American Association for Advancement of Science (AAAS)
Activities: elected Fellow of AAAS in recognition for “distinguished contributions to understanding phonon confinement effects in nanostructures”.

- Senior Member, Institute of Electrical and Electronics Engineers (IEEE)
Activities: serve as an associate editor of the journal *IEEE Transactions on Nanotechnology*; gave several invited and keynote talks at the IEEE conferences; served as IEEE distinguished speaker on phonon engineering; my invited feature article “New Materials and Designs can Keep the Chips Cool” was published in *IEEE Spectrum* (October 2009).
- Member, The American Physical Society (APS)
Activities: participated in most APS March meetings since 1997; each year sponsored conference travel of many graduate students to APS conferences.
- Member, Electrochemical Society, Inc. (ECS)
Activities: chairs four conference sessions; gave several invited talks at the ECS symposia.
- Elected Member, *Eta Kappa Nu* Engineering Honor Society, since 1994

UNIVERSITY SERVICE

- Founding Chair, UCR Materials Science and Engineering Program (MS&E), 2006 – present
Major Accomplishments: I wrote the MS&E program proposal and led the campus efforts for its approval and program establishment despite current California’s unfavorable economic circumstances. The program, focused on *materials for nanotechnology, energy and sustainability*, includes 40 faculty members from eight participating departments. The undergraduate program leading to BS in MS&E was approved by the UC Riverside Academic Senate in 2007. The inaugural class of ~20 students was welcomed in 2008. The first BS students were graduated in 2010. The campus-wide graduate program leading to MS and PhD degrees in MS&E was approved by the University of California President Mark G. Yudof on August 24, 2009. The first cohort of ~10 PhD graduate students was accepted for Fall quarter of 2010. Presently, two Graduate Advisors, an Undergraduate Advisor and Program Assistant advise MS&E students on academic and research issues. The new Materials Science and Engineering (MSE) building, expected to be completed in 2010, will expand MS&E research and teaching facilities.
- Member, UCR Strategic Planning Committee, *Subcommittee on Academic Excellence* chaired by UCR Chancellor Timothy White, 2009 – 2010
Activities: worked on strategic planning issues and provided input for the report “*UCR 2020: The Path to Preeminence – A Living Document to Guide our Future.*”
- Member, Materials Science and Engineering Faculty Search Committee, 2009 – 2010
- Chair, Materials Science and Engineering Faculty Search Committee, 2007 – 2009
Major Accomplishments: lead the committee’s efforts to hire the first MS&E core faculty members, which resulted in three new professors joining the BCOE
- Principal Investigator, NSF Research Experience for Undergraduates (REU) Site on Nanomaterials and Devices, UCR, 2006 – 2009

- Member, Materials Science and Engineering (MS&E) Building Committee, 2005 – 2010
- Director, Summer Undergraduate Research Institute in Science and Engineering (SUNRISE), Undergraduate Institute on Nanomaterials, NSF REU Site, UCR, 2006 – 2008
- Other Professional Service Activities for the University of California
 - Member, UC-Riverside Academic Senate Committee on Research, 2006 – 2008
 - Chair, Electrical Engineering Graduate Committee, 2006 – 2008
 - Graduate Advisor, Department of Electrical Engineering, 2006 - 2008
 - Chair, Electrical Engineering Undergraduate Committee, 2003 – 2005
 - Undergraduate Advisor, Department of Electrical Engineering, 2003 – 2005
 - Undergraduate Advisor, Computer Engineering, Joint Program offered by Department of Electrical Engineering and Department of Computer Science, 2004 – 2005
 - Chair, ABET – 2000 Electrical Engineering Committee, 2003 – 2005
 - Member, College of Engineering Dean Search Committee Member, 2004 – 2005
 - Member, UCR ad hoc Committee for Tenure and Promotion, 2002 – present
 - Member, Electrical Engineering Faculty Search Committee, 1999 – 2003
 - Member, UCR Focus Group on Nanotechnology, 1999 – 2005

EXTRAMURAL RESEARCH FUNDING

Research Group Supervision and Laboratory Development

- In 1999, was hired by UCR with a small “theorist” initial complement. Despite the small start-up money and absence of relevant infrastructure, I was able to organize an experimental *Nano-Device Laboratory* (NDL) entirely with the extramural funds. This task was considered, by many peers, to be unachievable for an assistant professor in a new department. With a number of grants from NSF, ONR, and ARO, I built unique experimental capabilities dedicated to nanoscale electrical, thermal and optical characterization.
- For the last five – six years my group’s extramural research budget was about ~ **\$800,000** per year. Currently, my group participates in the work of two major national research centers: SRC – DARPA funded FCRP Functional Engineered Nano Architectonics (FENA) center with the headquarters at UCLA and FCRP Interconnect Focus Center (IFC) with the headquarters at Georgia Institute of Technology. We were part of the DARPA – DMEA funded UCR – UCLA – UCSB Center for Nanoscience Innovations for Defense (CNID) until completion of its mission. Among the industry sponsors of my research group are IBM, Raytheon, Intel, Synopsis and TRW.

Highlights of Extramurally Funded Research Activities

The annual funding of ~ **\$800,000** allows me to support ~ **14 PhD** graduate students and two visiting researchers. The list below includes a selection of grants representing different aspects of NDL research. For a complete funding record please refer to *UCR Grant Activity* file.

- DARPA – DMEA (2010 – present) through Center for Nanoscale Science and Engineering: “3D Electronics,” co-PI: **\$121,420** per year (my share only)
- SRC – DARPA (2010 – present) through FCRP FENA: “Transport and Thermoelectric Properties of Topological Insulators,” UC-Riverside PI: **\$150,000** per year (co-PIs: Jing Shi, C.N. Lau, Physics Dept., UCR)
- UCR Academic Senate Fellowship (2010 – present): “Mechanically Exfoliated Topological Insulators,” single PI: **\$6,180**
- SRC – DARPA (2009 – present) through FCRP Interconnect Focus Center (IFC): “Graphene Lateral Heat Spreaders and Composite Substrates for Interconnect Applications,” co-PI: ~ **\$350,000** for three years (my share only)
- DOD ONR (2009 – present): “Graphene *Quilts* for Thermal Management of GaN Power Electronics,” single PI: **\$450,000** for three years
- SRC – DARPA (2009 – present) through FCRP Functional Engineered Nano Architectonics (FENA) Center: “Low-Energy-Dissipation Low-Noise Carbon-Allotrope-Based Nanoelectronics,” co-PI: **\$565,000** for three years (my share only)
- DOD AFOSR (2007 – present): “Phonon-Engineered Heterostructures for Enhanced Carrier Mobility in Electronic and Optoelectronic Devices,” single PI: **\$600,000** for three years
- DOE (2007 – 2010): “Nanostructured Materials for Concentrator Photovoltaic Solar Cells,” co-PI: **\$100,000** (my share only)
- SRC – DARPA (2007 – 2009) through FCRP Interconnect Focus Center (IFC): “Graphene for Thermal Management of Interconnects; co-PI: **\$250,000** for two years (my share only)
- DOD AFOSR (2007 – 2009): “Modeling-Based Optimization of Nanostructures for Solar Cells and IR Photodetectors,” co-PI: **\$265,000** for two years (my share only)
- DOD ARO (2006 – 2007): “Time-Resolved Single Photon Spectroscopy of ZnO Nanostructures,” single PI: **\$110,550** for one year
- NSF REU Site (2005 – 2008): “Undergraduate Research and Education (REU) Site for Nanomaterials and Nanodevices,” PI and Director: **\$300,000** for three years
- NSF – SRC (2005 – 2007): “*Nanophononics*: A New Approach to Electron Transport Enhancement in Nanoscale Devices,” single PI: **\$100,000** for two years
- SRC – DARPA (2003 – 2009) through FCRP Center on Functional Engineered Nano Architectonics (FENA): “Phonon Engineering in Hybrid Bio-Inorganic Nanoelectronics,” co-PI: approximately **\$800,000** for six years (my share only)
- NASA (2006 – 2008): “High Efficiency Radiation-Hard Nanostructure-Based Solar Cells,” co-PI: **\$215,000** for two years (my share only)
- UC MICRO (2005 – 2006): “Micro-Raman Mapping of Strain Distribution in Heterostructures,” single PI: **\$55,000** for one year

- NSF (2001 – 2006): “CAREER: Thermal Management at Nanoscale: Fine-Tuning the Phonons,” single PI: **\$410,000** for four years
- DOD ONR DURIP (2003 – 2004): “Temperature Distribution and Self-Heating in GaN Transistors,” single PI: **\$225,656** for one year
- DOD ONR (2002 – 2005): “Performance Enhancement of AlGaN High-Power Transistors,” single PI: **\$341,987** for three years – *ONR Young Investigator Award*
- NSF SGER (2003 – 2005): “Phonon Engineering Concepts for Nanoscale Devices and Circuits,” single PI: **\$59,800** for one year
- SRC (2002 – 2005): “Silicon-Integrated Hybrid-Chip Molecular Quantum Computing Gates,” single PI: **\$35,000** for one year
- NSF NER (2001 – 2003): “High-Efficiency Quantum Dot Superlattice Based Thermoelectric Devices,” single PI: **\$80,000** for two years
- DOD AFOSR (2000 – 2002): “Phonon Annihilation in Semiconductor Nanostructures,” single PI: **\$184,999** for two years

CONSULTING FOR INDUSTRY AND ACADEMIA

- Andromeda Scientific, Los Angeles, California, USA, 2010 – present
- Boeing Corporation, Research & Technology Division, Chicago, Illinois, USA, 2010
- California Institute of Nanotechnology, Fremont, California, USA, 2007 – 2009
- Raytheon Vision Systems, Goleta, California, USA, 2005 – 2006
- TRW, Inc., San Bernardino, California, USA, 2000 – 2002
- CFD Research Corporation, Huntsville, Alabama, USA, 2000 – present
- Physical Optics Corporation, Newport Beach, California, USA, 2002 – present
- Echem Innovations, Notre Dame, Indiana, 1997 – 1999
- Department of Chemical Engineering, University of Notre Dame, USA, 1996 – 1997

OVERVIEW OF RESEARCH ACHIEVEMENTS

- ***Thermal Properties of Graphene and other Carbon Materials:*** The unusually high *intrinsic* thermal conductivity of graphene – a single atomic layer of sp²-bound carbon atoms – was ***discovered*** in my laboratory in 2008 (A.A. Balandin, et al., *Nano Letters*, **8**, 902 (2008); cited >300 times in two years). In order to perform the thermal measurements with graphene, I invented a new experimental technique based on Raman spectroscopy. This technique for studying thermal transport in graphene was reproduced and/or modified in many laboratories worldwide, e.g. UT-Austin, Georgia Tech, Purdue, CNRS, Korean U., and used for other nanostructures, e.g. for nanowires, in UC-Berkeley. My group developed the ***first*** detail theory with an explanation of why the thermal conductivity of 2D graphene can be higher than that of 3D graphite (D.L. Nika, et al., *Physical Review B*, **79**, 155413 (2009) - *Editors’ Selection Paper* and D.L. Nika, et al., *Applied Physics Letters*, **94**, 203103 (2009)). We were the ***first*** who succeeded in experimental demonstration and theoretical description of

the evolution of heat conduction in transition from 2D to 3D system (S. Ghosh, et al., *Nature Materials*, **9**, 555 (2010)). These results had important implications and led to major government funding for research on graphene for thermal management. For a review of thermal properties of graphene and practical **applications**, see A.A. Balandin, invited feature article “Chill out: New materials and designs can keep chips cool” in *IEEE Spectrum*, October, 2009. Our work on thermal properties of graphene attracted major interest as evidenced by >30 invited, keynote and plenary talks in two years, citations and media coverage. My group has also made important contributions to experimental investigation of the thermal conductivity of other carbon allotropes and composite (in collaboration with Cambridge University): nano-crystalline diamond, diamond-like carbon, amorphous carbon, etc.

- **Nanoscale Phonon Engineering:** I was one of the *pioneers* of the *phonon engineering* concept (the term *phonon engineering* became commonly accepted after the paper by A. Balandin and K.L. Wang, *Physical Review B*, **58**, 1544 (1998), which was cited >210 times; it might also be the *first* time this term appeared in a journal publication). The *phonon engineering* is defined as controlled modification of the phonon spectrum and phonon transport in nanostructures with the goal of achieving better electron mobility or modification of thermal conductivity or other property, allowing for performance enhancement of electronic, thermoelectric or optoelectronic devices. I have extensively published on the subject, performing both theoretical and experimental research (e.g. my PhD student’s paper, J. Zou and A.A. Balandin, *J. Applied Physics*, **89**, 2932 (2001) was cited >200 times). The phonon engineering became conventionally accepted subfield of nano-science as evidenced by many recent international conferences explicitly dedicated to this subject. I have given numerous plenary, keynote and invited talks on phonon engineering at international conferences (e.g. recent keynote talk at *ICREA Workshop on Phonon Engineering*, Barcelona, Spain, 2010; invited “symposium opening” talk, at *MRS Symposium on Phonon Engineering*, Boston, USA, 2007 and others). Many of these talks were scheduled as *opening talks* for the whole symposia or sessions on phonon engineering. In 2005, I introduced at UCR a course on *Nanoscale Phonon Engineering* (EE216) – perhaps the first of such kind.
- **Low-Noise Graphene Field-Effect Transistors:** My research group (in collaboration with M. Shur, RPI, USA and S. Rumyantsev, Ioffe Institute, Russia) demonstrated the **first top-gate** single-atomic-layer graphene transistors with the low level of $1/f$ noise. The devices were built in my lab at UCR. The low level of the $1/f$ noise is an essential condition for any envisioned application of graphene in communication systems or sensors. The $1/f$ noise up-conversion results in increased phase noise of the communication systems and sensors (G. Liu, et al., *Applied Physics Letters*, **95**, 033103 (2009) and Q. Shao, et al., *IEEE Electron Device Letters*, **30**, 288 (2009)). We were also the **first** to carry out a systematic study and investigate the effects of ambient conditions and aging on electronic noise in graphene field-effect transistors (S. Rumyantsev, et al., *J. Physics: Condensed Matter*, **22**, 395302 (2010)). This knowledge is important for practical applications. Our low-noise top-gate graphene transistors were highlighted in *Nature Nanotechnology’s* Research News.

- ***Mechanical Exfoliation and Characterization of Bi₂Te₃-Family of Topological Insulators:*** Topological insulators constitute a newly discovered class of quantum materials with a bulk insulating gap and conducting surface states that are topologically protected against scattering by the time-reversal symmetry. My group became the *first* to succeed in “graphene-like” mechanical exfoliation of the atomically-thin films of topological insulators of Bi₂Te₃ family (D. Teweldebrhan, et al., *Nano Letters*, **10**, 1209 (2010)). We demonstrated and characterized films with the thickness down to a single *quintuple* – a structural unit of the crystal, which consists of five atomic planes of Te-Bi-Te-Bi-Te atoms (D. Teweldebrhan, et al., *Appl. Phys. Lett.*, **96**, 053107 (2010) – this paper was highlighted on the cover of the journal issue). Our results attracted immediate attention of the research community as a possible new way for achieving better quality of the films made of topological insulators. My group has also experimentally observed the crystal symmetry breaking in atomically thin films of Bi₂Te₃ and proposed the use of Raman spectroscopy as nanometrology tools for topological insulators (K.M.F. Shahil, et al., *Appl. Phys. Lett.*, **96**, 153103 (2010)). Our original technique for producing topological insulator films was highlighted in *Nature*. The news story was entitled *Condensed matter: Cutting it fine* (*Nature*, 463, 852-853, 2010).
- ***Properties of Wurtzite Quantum Dots and Nanostructures:*** Wurtzite (WZ) ZnO and GaN nanostructures have strong potential for blue and UV optical and other applications. The optical properties of WZ nanostructure are substantially different from those of nanostructures made of conventional materials with the cubic crystal lattice. Together with my group members, I have made important theoretical and experimental contributions to understanding the excitons, phonons, carrier recombination and optical properties of WZ ZnO and GaN nanostructures. Our results clarified the origin of UV luminescence from ZnO quantum dots (e.g. V.A. Fonoberov, et al., *Applied Physics Letters*, 85, 5971 (2004) – cited >100 times); explained the origin of the peak shifts in resonant Raman spectra of ZnO quantum dots (e.g. K.A. Alim, et al., *Applied Physics Letters*, 86, 053103 (2005) – cited >120 times); revealed the mechanisms of the carrier recombination in WZ nanostructures; and described unique discrete optical phonon spectrum in such materials. I have published 8 journal papers on ZnO and GaN quantum dots, which made major impact in the field, as evidenced by the papers’ citation records: these papers were cited >800 times in just a few years. Our results are important for applications of WZ nanostructures in optoelectronic and photonic devices.
- ***Electron States and Optical Absorption in Quantum Dot Superlattices:*** Ordered or partially ordered quantum dot superlattices (QDS) constitute a special type of nanostructure with many unique properties different from those of individual quantum dots and quantum well superlattices. The semiconductor QDS are under investigation for applications in thermoelectric devices, photovoltaic solar cells and photodetectors. I have developed some of the earliest theoretical models and computer simulation tools for electronic states in QDS with the charge-carrier mini-bands (e.g. two papers A.A. Balandin and O.L. Lazarenkova, *Applied Physics Letters*, 82, 415 (2003) and *J. Applied Physics*, 89, 5509

(2001) were cited >100 times). These models were used in development of the commercial software produced by industry (e.g. CFD Research Corporation). Our models were also used for simulation of the optical absorption in QDS photovoltaic solar cells.

- ***Low-Frequency Flicker Noise in GaN Materials and Devices:*** I have experimentally investigated the low-frequency flicker noise in GaN materials, heterostructures and transistors. In 1998, we demonstrated (with K.L. Wang, UCLA) the lowest noise level in GaN/AlGaIn heterostructure field-effect transistors (A. Balandin, et al., *IEEE Electron Device Letters*, 19, 475 (1998)). The noise spectral density achieved in our transistors was comparable to the one in conventional Si or GaAs technologies. The low noise level is essential for applications of GaN transistors in microwave devices, communications and radar systems. I have published around 5 papers on the subject, which made substantial impact in the field as evidenced by my invitations to chair an international conference on noise in electronic devices, to serve in several noise symposia program committees, to edit a book on noise, to give invited talks at international conferences, as well as by the citation record of the papers.
- ***Heat Conduction in AlGaIn Thin Films and Alloys: Applications in Thermal Management:*** GaN is the most promising new material for applications in microwave, high-power and optoelectronic devices. Because GaN – wide band-gap semiconductor – was selected for the use in the high-power devices, its thermal properties were of major interest. The heat removal from GaN-based transistors or optoelectronic devices had always encountered problems. I became interested in the problem in 2000 being puzzled by the discrepancy between the high theoretical limit of GaN's thermal conductivity and rather low values reported experimentally. In the set of modeling and experimental papers I, together with my group members, investigated the effect of dislocations, impurities and defects on the thermal conductivity of GaN films and AlGaIn alloys (e.g. J. Zou, et al., *J. Applied Physics*, 92, 2534 (2002) – cited >70 times). Our published results were well cited and had important practical applications. For this work I was awarded the *US Office of Naval Research (ONR) Young Investigator Award*. In 2005 we were the first who examined theoretically a possibility of thermoelectric applications of AlGaIn for cooling GaN device structures
- ***Quantum Computing and Alternative Computational Paradigms:*** I have made substantial contributions to the study of a solid-state implementation of a quantum computer with semiconductor quantum dots and heterostructures. I took part in investigation (with E. Yablonovich, UC-Berkeley and K.L. Wang, UCLA) of the spin-based quantum computing in Si-Ge heterostructures (e.g. R. Vrijen, et al., *Physical Review A*, 62, 1, 2000 was cited >400 times). I proposed an optically-driven quantum computer implemented with asymmetric quantum dots. I have studied (with S. Bandyopadhyay, Notre Dame and UNL) a number of quantum-dot based reversible computational paradigms, which utilized the charge or spin degrees of freedom for information encoding.

- **Non-Linear Optic Effects in Semiconductor Quantum Wires:** I have theoretically studied (with S. Bandyopadhyay, Notre Dame and UNL) the excitonic optical non-linearity in semiconductor quantum wires. In a set of theoretical papers published in *Physical Review B*, we proposed a new method for the non-linearity enhancement in the magnetically biased quantum wires. Our work was part of the all-optical switching and frequency modulation research.

HIGHLIGHTS OF TECHNICAL PUBLICATIONS

Overview of Publication Record

- I am an author of about **150** technical journal papers, more than **240** conference papers, proceedings or abstracts, **12** invited book chapters, and editor/author of **3** books. I am also an author of several semi-technical and popular science publications, including an invited review "*Chill Out: New Materials and Designs Can Keep Chips Cool*," published in *IEEE Spectrum*, October, 2009.
- My *h*-factor is ~**33** (started to publish actively since **1997**); the number of citations tracked by ISI is ~**4,000**. My current citation rate is >800 citations per year. Below is a list of several high-impact publications, representing different aspects of my research. A complete publication list can be found at <http://ndl.ee.ucr.edu>

Selected High-Impact Publications on Different Topics in Chronological Order

1. A.A. Balandin and K.L. Wang, "Significant decrease of the thermal conductivity due to phonon confinement in quantum wells," *Phys. Rev. B*, **58**, 1544 (1998) – cited >210 times
2. A.A. Balandin, S. Morozov, S. Cai, K.L. Wang, G. Wijeratne and C.R. Viswanathan, "Low flicker-noise GaN/AlGaIn heterostructure field-effect transistors for microwave communications," *IEEE Trans. Microwave Theory & Tech.*, **47**, 1413 (1999) – cited >40 times
3. R. Vrijen, E. Yablonovitch, K.L. Wang, A.A. Balandin, V. Roychowdhury and D. DiVincenzo, "Electron-spin-resonance transistors for quantum computing in silicon-germanium heterostructures," *Phys. Rev. A*, **62**, 012306 (2000) – cited >400 times
4. J. Zou and A.A. Balandin, "Phonon heat conduction in a semiconductor nanowire," *J. Appl. Phys.*, **89**, 2932 (2001) – cited >200 times
5. D. Kotchetkov, J. Zou, A.A. Balandin, D.I. Florescu and F.H. Pollak, "Effect of dislocations on thermal conductivity of GaN layers," *Appl. Phys. Lett.*, **79**, 4316 (2001) – cited >45 times

6. V.A. Fonoberov and A.A. Balandin, "Ultraviolet photoluminescence in ZnO quantum dots: Confined excitons vs. surface excitons," *Appl. Phys. Lett.*, **85**, 5971 (2004) – cited >100 times
7. K.A. Alim, V.A. Fonoberov and A.A. Balandin, "Origin of the optical phonon frequency shifts in ZnO quantum dots," *Appl. Phys. Lett.*, **86**, 053103 (2005) – cited >120 times
8. I. Calizo, A.A. Balandin, W. Bao, F. Miao and C.N. Lau, "Temperature dependence of the Raman spectra of graphene," *Nano Letters*, **7**, 2645 (2007) – cited >70 times
9. A.A. Balandin, S. Ghosh, W. Bao, I. Calizo, D. Teweldebrhan, F. Miao and C.N. Lau, "Superior thermal conductivity of graphene," *Nano Letters*, **8**, 902 (2008) – cited >300 times
10. G. Liu, W. Stillman, S. Rumyantsev, Q. Shao, M. Shur and A.A. Balandin, "Low-frequency electronic noise in the double-gate single-layer graphene transistors," *Appl. Phys. Lett.*, **95**, 033103 (2009)
11. S. Ghosh, W. Bao, D.L. Nika, S. Subrina, E.P. Pokatilov, C.N. Lau and A.A. Balandin, "Dimensional crossover of thermal transport in few-layer graphene," *Nature Materials*, **9**, 555 (2010)
12. X. Yang, G. Liu, A.A. Balandin and K. Mohanram, "Triple-mode single-transistor graphene amplifier and its applications," *ACS Nano*, **4**, 5532 (2010).
13. D. Teweldebrhan, V. Goyal and A.A. Balandin, "Exfoliation and characterization of bismuth telluride atomic quintuples and quasi-two-dimensional crystals," *Nano Letters*, **10**, 1209 (2010).
14. K.M.F. Shahil, M.Z. Hossain, D. Teweldebrhan and A.A. Balandin, "Crystal symmetry breaking in few-quintuple Bi₂Te₃ films: Applications in nanometrology of topological insulators," *Appl. Phys. Lett.*, **96**, 153103 (2010).
15. V. Goyal, D. Teweldebrhan and A.A. Balandin, "Mechanically-exfoliated stacks of thin films of Bi₂Te₃ topological insulators with enhanced thermoelectric performance," *Appl. Phys. Lett.*, **97**, 133117 (2010).

REFERENCES

The references on my behalf from several distinguished professors, including Nobel Prize winners, are available upon request.

BIOGRAPHY



Alexander A. Balandin received his BS (1989) and MS (1991) degrees *Summa Cum Laude* in Applied Physics & Mathematics from the Moscow Institute of Physics & Technology (MIPT), Russia. He received his second MS (1995) and PhD (1997) degrees in Electrical Engineering from the University of Notre Dame, USA. He worked as Research Engineer at the Department of Electrical Engineering, University of California – Los Angeles (UCLA). In 1999 he joined the Department of Electrical Engineering, University of California – Riverside (UCR), where he is Professor of Electrical Engineering and Chair of Materials Science and Engineering. He leads the Nano-Device Laboratory (NDL), which he organized in 2000. In 2005 he was Visiting Professor at the University of Cambridge, UK, where he was elected Associate Scholar of Pembroke College. In 2007 he became the Founding Chair of Materials Science and Engineering (MS&E) program at UCR. He led the campus efforts resulting in introduction of BS, MS and PhD degrees in MS&E.

Professor Balandin's research interests are in the area of advanced materials, nanostructures and nanodevices. He carries out both experimental and theoretical research. He is recognized for his contributions to investigation the phonon and exciton confinement effects in semiconductor nanostructures; development of the *phonon engineering* concept; investigation of thermal transport in graphene, carbon materials and nanostructures; $1/f$ noise in electronic devices; and device applications of quantum dots and graphene. In 2008, his group made an important discovery of extremely high intrinsic thermal conductivity of graphene and explained it theoretically. Balandin group has also succeeded in demonstration of the first low-noise top-gate graphene transistor, graphene triple mode amplifier, and carried out the first “graphene-like” mechanical exfoliation of topological insulator thin films.

Professor Balandin published more than 150 technical papers, 10 invited review chapters and edited/authored three books and a comprehensive five-volume *Handbook of Semiconductor Nanostructures and Nanodevices* (ASP, 2006). His *h*-factor is above 33, and his papers were cited more than 4000 times (ISI). His work was recognized by the ONR Young Investigator Award, National Science Foundation CAREER Award, University of California Regents Award, US Civil Research & Development Foundation (CRDF) Award, and Merrill Lynch Innovation Award for “commercially valuable engineering research”. He is Fellow of The Optical Society of America (OSA), Fellow of The International Society for Optical Engineering (SPIE) and Fellow of The American Association for Advancement of Science (AAAS). He is also Senior Member of IEEE, and Member of Eta Kappa Nu, American Physical Society (APS), Materials Research Society (MRS) and Electrochemical Society (ECS).

He serves as an Editor-in-Chief of the *Journal of Nanoelectronics and Optoelectronics* (JNO), and as an Associate Editor of *IEEE Transactions on Nanotechnology* (TNANO). His research group is part of the SRC – DARPA Center on Functional Engineered Nano Architectonics (FENA), and previously was part of SRC – DARPA Interconnect Focus Center (IFC). The work of his research group has supported though the grants from NSF, ONR, ARO, NASA, AFOSR, SRC, DARPA, CRDF, UC MICRO, IBM, TRW and Raytheon. More information about his research can be found at <http://ndl.ee.ucr.edu/>.