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Current Positions

Kenneth T. Norris Professor of Engineering
Professor, Department of Biomedical Engineering
Professor, Mork Family Department of Chemical Engineering and Materials Science
Professor, Department of Physics
Founding Member, Center for Photonic Technology (1983)
Founding Member, Center for Electron Microscopy & Microanalysis (1984)
Member, Center for Neural Engineering
Founding Member, Laboratory for Molecular Robotics (1994)

Positions Held

Chairman, Department of Materials Science & Engineering, USC (1990-1993)
Thrust Leader, National Center for Integrated Photonic Technology, USC (1990-1993)

Education

1971	Ph.D.	(Materials Science and Physics), California Institute of Technology
1968	M.Sc.	(Physics) Indian Institute of Technology, Kanpur, (U.P.) India.
1966	B.Sc.	Lucknow University, Lucknow, (U.P.) India

Awards & Honors

1. Fellow, American Physical Society
2. Member, New York Academy of Sciences.
3. Alfred P. Sloan Fellow in Physics, l977-79
4. DARPA Electronics Technology Office Award for "Sustained Excellence in Performance", USC/LSU MURI Team (A. Madhukar, P.I.), 1997
5. Outstanding Research Achievement Award (School of Engineering, University of Southern California) 1988.
6. NASA Certificates of Recognition, l981 and 1982: For work relating to the nature of Si/SiO_2 interfaces and their radiation hardness characteristics.
7. NASA Certificate of Recognition, 1986: For work relating to MBE growth of GaAs/InGaAs system and usage of RHEED for examining the nature of growth.
8. NASA Certificate of Recognition, 1988: For work establishing RHEED as a pragmatic tool for monitoring MBE growth conditions.
9. Founding President, Southern California Chapter of the Materials Research Society (1986-1988).
10. Member, National Panel on Nanoelectronics, Nanophotonics, & Nanomagnetics, National Nanotechnology Initiative (NNI), 2004.
11. Member & Sub-Panel Co-Chair, National Workshop on Solar Energy, Department of Energy, 2005.

12. Member, ARPA-E First Review Panel on Solar Energy, 2009
13. Member, NSF Adhoc Advisory Committee on Sustainable Energy, MPS Div. (2010)

Research Areas

A. Madhukar heads the Nanostructure Materials and Devices Laboratory (NMDL) whose major activities combine modeling, simulation, and experiments to push the frontiers of nanostructure synthesis and their applications to information processing, human environment issues (such as solar energy conversion and pathogen detection) and human health issues (such as disease detection and therapy). These activities fall in **five inter-related categories**:

(1) Semiconductor Quantum Nanostructures and Devices

A. Epitaxial Nanostrucutres

A long-term focus of the Madhukar group has been on **combined experimental, theoretical, and computer simulation studies** of directed epitaxical self-assembly and optical, structural, and electrical properties of semiconductor nanostructures. The Madhukar Group has made seminal contributions to the field **of semiconductor heteroepitaxy** by introducing Kinetic Monte-Carlo simulations of heterojunction formation based upon atomistic and kinetic models of growth and combining it with in-situ measurements of real-time electron diffraction intensity dynamics to control and optimize growth. His group introduced such commonly practiced concepts and approaches as growth interruption, alternate beam deposition (also known as migration enhanced epitaxy, MEE), and introduction of ultra-thin chemical contrast layers (dubbed marker layers) during growth to reveal the structural and chemical nature of the growth front profile in cross-sectional scanning and transmission electron microscopy. The impact of these insights and practices was demonstrated through the fabrication and characterization of such **electronic devices** as the *inverted* HEMTs (high electron mobility transistor), MISFETs (metal-insulator semiconductor field effect transistor), and RTDs (resonant tunneling diodes) and **optoelectronic devices** such as p-i-n detectors and resonant-cavity spatial light modulators. Indeed, the first monolithically integrated phototransistor and the first hybrid optoelectronic optical switch comprising inter-connected detector, modulator, transistor, and resonant tunneling diode were demonstrated by the Madhukar group in 1990-91.

Between 1987 and 1994, the Madhukar group introduced, demonstrated, and developed the concept of *surface stress engineering* through introduction of surface curvature via creation of appropriate mesa structure arrays that has made a major impact on the development of the fields of **stress-engineered self-organized nanostructures of lattice-matched as well as lattice-mismatched materials.** The concept enabled the first purely growth-controlled realization of nanowires and quantum boxes. It also enabled the first demonstration of the suppression of lattice-mismatch induced extended defects such as dislocations.

During the same period the group demonstrated for the first time the formation of *defect-free* (coherent) nanoscale 3D islands in lattice-mismatch induced strained epitaxy on planar (i.e.unpatterned) substrates. Such stress-driven coherent islands were later dubbed ***self-assembled quantum dots*** (SAQDs). During 1993-95, the group introduced and demonstrated the concept of stress-driven **vertical self-organization** of SAQDs and employed it to realize **one of the earliest quantum dot lasers.** During 1995-1998 the group introduced innovations such as punctuated island growth (PIG) and variable deposition amount (VDA) to allow realization of unprecedented uniformity of island sizes and shapes. A particular application of the SAQD work pursued from 1998-2010 focused on the development of high performance **QD infrared photo-detectors** (QDIPs) in the mid and long wavelengths of importance to night vision and environmental and biomedical sensing. Indeed, in 2010, the group demonstrated for the first time a factor of ~12 enhancement in the QDIP detectivity by the proper placement of the QDIP in a resonant cavity as designed through device simulation. **The resonant cavity**, made of alternating layers of GaAs and air, is an example of the **integration of the so-called metamaterial and quantum dots**, an area of emerging inmportance to realizing solid-state devices suited for quantum information processing.

Since 2011 a **new thrust** has been the realization of regular arrays of spectrally highly uniform nanotemplate-driven site-controlled **single quantum dot as single photon emitters** suitable for **on-chip integration with metamaterials for optical quantum information processing systems.**

A major area of effort continues on examining fundamental issues faced in the **integration of highly inhomogeneous materials** (significant differences in lattice constant, structure, and bonding) into composite nanostructures with advanced functionality.

B. Colloidal Nanostructures

Since 2003, a significant component of the effort on quantum nanostructures involves **colloidal synthesis** of semiconductor nanocrystals (quantum dots, rods, tetrapods, etc.) and nanoscale composites of semiconductor-metal nanocrystals (nanoscale photodiodes) to provide functionality beyond luminescence.

Beginning 2000, the Madhukar group introduced, and has since been exploring, the creation of **novel hybrid nanostructures** involving **composites of** the solution-grown nanocrystals quantum structures and epitaxically grown planar and non-planar nanostructures that together provide functionalities not possible within either class. This has opened the doors to untold possibilities resulting from the integration of the material versatility of the colloidal approach and the sophistication of the advanced device architecture and processing / fabrication of epitaxical technologies. An example of this is provided under item (2) below.

(2) Hybrid Integrated Nanocrystal-Epitaxial Quantum systems: A New Paradigm for Solar Energy Conversion.

Given the efforts noted under (1), a synergistic effort has been underway since 2001 on the integration of colloidal nanocrystal quantum dots on crystalline semiconductor substrates bearing buried epitaxical nanostructures to examine and manipulate energy and charge transfer processes between the two. The integration of these two vastly different classes of quantum nanostructures holds the potential for truly novel hybrid structures with functionalities suited for a variety of quantum information processing, biomedical applications, and solar energy conversion. We have demonstrated efficient non-radiative energy transfer (NRET) from nanocrystal quantum dots to near-surface buried quantum wells and nanowires possessing high electron and hole mobilities and NRET induced photocurrent, thus opening a new paradigm for solar energy conversion. Such structures are also particularly well-suited for sensing weak environmental and biomedical pathogen signals and their on-chip amplification.

(3) Functional Active Nanosystems (FANs) for Biology and Nanomedicine

Complementary to the semiconductor epitaxy based quantum nanostructures, Madhukar group has is focused upon pushing the frontiers of the colloidal solution chemistry based synthesis, manipulation, characterization, and applications of novel composite nanostructures such as epitaxially-grown semiconductor-metal composite nanocrystals. Such monolithically-integrated nanocrystal composites can provide active function, such as photovoltaic response, that goes beyond the hitherto limited use of semiconductor nanocrystal quantum dots as fluorescent probes for biological and biomedical applications or metallic nanocrystals as local heaters to induce cell death.. We have dubbed this class of nanostructures Functional Active Nanosystems (FANs). Through modeling and simulation we have shown that photovoltaic FANs, when attached to the plasma membrane of neuronal cells, can be utilized as “Cellular Prosthesis” for inducing repetitive firing of the action potential under continuous light.

The Madhukar group is a founding member of the USC Laboratory for Molecular Robotics that pioneered the manipulation of nanoparticles, linked together via organic linkers, on protein covered solid surfaces, including in solution.

(4) Multi-Marker, Live-Cell Imaging under Controlled External Stress over Prolonged Times:

The Madhukar group is pushing the frontiers of real-time imaging of multiple intra-cellular molecular level biomarkers and cell morphology change in live cells under controlled stress with a particular focus on apoptosis, a process implicated in a wide variety of diseases including cancer and neurodegenerative diseases. This work has led to the first quantitative data base for Ca^{2+} concentration dynamics during apoptosis. It has enabled us to create and analyze the first theoretical model for the coupled dynamics of mitochondria released cytochrome c and Ca^{2+}, demonstrated experimentally to be at the core of the mitochondria-mediated pathway of apoptosis.

Such imaging efforts are combined with the nanocrystal quantum dots as long-time stable fluorescent labels of biomarkers to examine the real-time movement of single molecules, such as axonal transport of growth factors under spatially localized and controlled stress implemented through culturing of neuronal network in appropriately designed and fabricated micro-fluidic chips.

(5) Abiotic-Biotic Interfacial Phenomena: Cell adhesion and Biomimetic Coatings for Prostheses

The fifth effort has a focus on interaction of proteins and live cells with solid surfaces as encountered in abiotic implants / prostheses. At the molecular level, this has important and useful similarities to the interactions between living entities (cells) and inorganic matter as involved in FANs.

Activities in the above noted areas involve inherently multidisciplinary approaches to integrated hybrid quantum nanostructure / biomolecular structure synthesis, characterization, device fabrication, and testing - aimed at information sensing and processing in applications ranging from communications to computing to biomedical diagnostics and prosthetics.

Specific focus:

1. Synthesis of semiconductor nanostructures via growth and processing utilizing the concepts of nanotemplates, engineered stress, and self-assembly.
   : Optical, structural, and electrical studies of quantum confined electronic states, carrier dynamics and energy relaxation processes
   : Applications to quantum dot based detectors, sensors, and single photon emitters.

2. Directed assembly of nanocrystal quantum dots on templated surfaces and their integration with epitaxical semiconductor quantum nanostructures to create novel structures for solar energy conversion.

3. Synthesis and characterization (structural, optical, and electrical) of colloidal nanocrystal composites based functional abiotic nanosystems (FANs) designed for probing, manipulating, and endowing new function to live cells.

4. Real-time simultaneous imaging of multiple biomarkers of intracellular processes and morphology in large numbers of live cells in the same population under controlled stress over prolonged times.

5. Examining the nature of the interaction, adsorption, and self-assembly of polypeptides and proteins on semiconductor surfaces with a view towards understanding aspects of biocompatible coatings.

6. High performance parallel computing and simulations of the synthesis, interaction with biomolecules, and mechanical behavior of multimillion atom nanostructures
   : Molecular Dynamics for atomic-scale stress and strain distribution and mechanical stability/stress relaxation.
   : Kinetic Monte-Carlo for nanostructure growth simulations on experimental time scales.

Professional Service

Member, Editorial Board, "Nanomedicine: Nanotechnology, Biology & Medicine"

Professional Societies

1. American Physical Society
2. American Chemical Society
3. American Association for the Advancement of Science
4. The Institute of Electrical and Electronics Engineers, Inc.
5. New York Academy of Sciences
6. Materials Research Society
7. American Society for Nanomedicine
8. Microscopy Society of America

Work Experience

1. Post-Doctoral Research Fellow, Dept. of Applied Physics, Caltech (1971-1972)
2. IBM Post-Doctoral Fellow, T.J. Watson Research Center (N.Y.), (1972-1974)
3. Louis Block Fellow, The James Franck Institute, University of Chicago (1974-1976)
4. Assistant Professor of Physics and Materials Science, USC (1976-1980)
5. Associate Professor of Physics and Materials Science, USC (1980-1984)
6. Professor of Physics and Materials Science, USC (1984-Present)
7. Kenneth T. Norris Professor of Engineering (1996-Present)
8. Professor of Biomedical Engineering (2003-Present)

Professional Experience - Research

1. Visiting Professor, Institute for Solid State Physics, Technical University, Berlin (September 1995-December 1995)
2. Consultant, Jet Propulsion Laboratory, Pasadena, California (October l976-September, 1988).
3. Consultant, U.S. Army Electronics Technology and Devices Laboratory, Ft. Monmouth, NJ (1985-1990).

4. Visiting Professor and Consultant, Laboratoire d'Automatique et d'Analyse Systemes du CNRS, Toulouse, France (May 1987).
5. Summer Visiting Fellow, University of Paris, Orsay (Summer l978).
6. Consultant, Exxon Research & Engineering Co., Linden, New Jersey, July l980.

Professional Experience – Leadership Roles

1. Chairman, Materials Science and Engineering (June 1990-September 1993)
2. Chair, Committee for Graduate Program in Scientific Computation, School of Engineering, 1991-92.
3. President, MRS Southern California Chapter (1986 - 1988).
4. Member, American Coordinating Committee (of the American Physical Society) for Chinese Scholar Program (1984 - 1991).
5. Editor, Proceedings of the SPIE Conference on "Growth of Advanced Semiconductor Structures" (Newport Beach, CA, March 1988).
6. Co-Editor, Proc. 1st International Conference on Metastable and Modulated Semiconductor Structures (Pasadena, USA, December 1982)
7. Member, Program Committee, 24th International Conference on Physics of Semiconductors (Berlin, Germany July 1996)
8. Member, Organizing Committee, 6th International MBE Conference (San Diego, CA, August, 1990).
9. Co-Chairman, MRS Symposium on "Advanced Methods for Characterizing Surfaces/Interfaces of Materials" (Boston, November/December, 1988).
10. Member, Program Committee, National MBE Workshop (Boston 1986; Los Angeles 1987; Lafayette 1988).
11. Organizer and Chairman, SPIE Conference on "Growth of Advanced Semiconductor Structures" (Newport Beach, CA, March 1988).
12. Organizer and Co-Chairman, MRS Symposium on "Materials for Aerospace Applications" (Anaheim, CA, April 1987).
13. Co-Chairman, SPIE Conference on "Growth of Compound Semiconductors" (Marriott Bay Point Resort, Florida, March 1987).
14. Member, International Advisory Committee, "The International Conference on Modulated Semiconductor Structures" (Kyoto, Japan, September, 1985; Montpellier, France, July 1987; Ann Arbor, USA, July 1989; Nara, Japan, Aug.1991); Member, Program Committee (Santa Barbara, 1997)
15. Co-Chairman and Founding Member, 1st International Conference on Metastable and Modulated Semiconductor Structures, (Pasadena, USA, Dec.1982).
16. Member, Selection Panel, DoD (Department of Defense Graduate Fellowship Program (1993-1995).
17. Member, Selection Panel, NSF (National Science Foundation) Program on Research Instrumentation, Division of Materials Research (1994-1996).
18. Member, Review Panel, DoE (Department of Energy) Review of High Performance Computing Programs of DoE (1994).
19. Member, NSF Review Panel for MRSECs (1999-2000).
20. Member, International Advisory Committee, International Conference on Modulated
21. Semiconductor Structures, (Linz, Austria, 2001).
22. Chair, Subcommittee for Low Dimensional Structures, International Symposium on Compound Semiconductors, (San Diego, 2003).
23. Member, National Panel on Nanoelectronics, Nanophotonics, & Nanomagnetics,

National Nanotechnology Initiative (NNI), 2004.

24. Member & Sub-Panel Co-Chair, National Panel and Workshop on Solar Energy, Department of Energy, 2005.
25. Member, NIH Study Group on Nanotechnology for Medicine, 2006 & 2008
26. Member, ARPA-E Review Panel on Solar Energy, 2009
27. Member, NIH Review Panel for P41 Center, 2009
28. Member, NSF Adhoc Advisory Committee on Sustainable Environment", MPS Directorate, (2010).

Invited Papers at Major Conferences

Over 150 invited talks, keynote lectures, etc. at National and International Conferences.

Publications

Over 350 peer-reviewed publications in high-impact journals. Complete list available upon request. **Overall H-Factor: 54**. Highest citation for a single *original* paper ~1650. Total citations ~ 11000.

Selected Publications (1990 – Present)

1. S. Guha, A. Madhukar, and K.C. Rajkumar, "Onset of incoherency and defect introduction in the initial stages of molecular beam epitaxical growth of highly strained InxGa1-xAs on GaAs(100)," Appl. Phys. Lett. **57**, 2110 (1990).
2. R. M. Kapre, A. Madhukar, and S. Guha, "Highly strained GaAs/InGaAs/AlAs resonant tunneling diodes with simultaneously high peak current densities and peak-to-valley ratios at room temperature," Appl. Phys. Lett. **58**, 2255 (1991).
3. K. Z. Hu, L. Chen, A. Madhukar, P. Chen, C. Kyriakakis, Z. Karim, and A. R. Tanguay, Jr., "Inverted cavity GaAs/InGaAs asymmetric Fabry-Perot reflection modulator," Appl. Phys. Lett. **59**, 1664 (1991).
4. L. Chen, R. M. Kapre, K. Z. Hu, and A. Madhukar, "High contrast optically bistable optoelectronic switch based on InGaAs/GaAs(100) asymmetric Fabry-Perot modulator, detector, and resonant tunneling diode," Appl. Phys. Lett. **59**, 1523 (1991).
5. K. Z. Hu, L. Chen, K. Kaviani, P. Chen, and A. Madhukar, "All optical photonic switches using integrated inverted asymmetric Fabry-Perot modulators and heterojunction phototransistors," IEEE Photonic Tech. L. **4**, 263 (1992).
6. K. Kaviani, K. Z. Hu, Q. H. Xie, and A. Madhukar, "Realization of high performance doped channel MISFETs in highly strained AlGaAs/InGaAs/AlgaAs based quantum wells," J. of Cryst. Growth **127**, 68 (1993).
7. K. Kaviani, A. Madhukar, J. J. Brown, and L. E. Larson, "Realization of doped-channel MISFETs with high breakdown voltage in AlGaAs/InGaAs based material system," Electron. Lett. **30**, 669 (1994).
8. A. Madhukar, Q. Xie, P. Chen, and A. Konkar, "Nature of strained InAs 3-dimensional island formation and distribution on GaAs(100)," Appl. Phys. Lett. **64**, 2727 (1994).
9. A. Konkar, A. Madhukar, and P. Chen, "Creating 3-D confined nanoscale strained structures via substrate encoded size-reducing epitaxy and the enhancement of critical thickness for island formation," Paper presented at MRS Spring '95 Meeting (April 17-21, 1995, San Francisco, CA), MRS Symposium Proc. **380**, 17 (1995).

10. Q. Xie, A. Madhukar, P. Chen, N. Kobayashi, "Vertically Self-Organized InAs quantum box islands on GaAs(100)," Phys. Rev. Lett. **75**, 2542 (1995).
11. A. Madhukar, "Semiconductor Nanostructures: Nature's Way," in "Low dimensional systems prepared by epitaxial growth or regrowth on patterned substrates," NATO ASI Proceedings, Eds. K. Eberl, P. Demeester, and P. Petroff, (Kluwer Scientific, The Netherlands, 1995), 19-33.
12. Q. Xie, A. Kalburge, P. Chen, and A. Madhukar, "Observation of lasing from vertically self-organized InAs three-dimensional island quantum boxes on GaAs(001)," IEEE Photonic Tech. Lett. **8**, 965 (1996).
13. R. Heitz, T.R. Ramachandran, A. Kalburge, Q. Xie, I. Mukhametzhanov, P. Chen and A. Madhukar, "Observation of re-entrant 2D to 3D morphology transition in highly strained epitaxy: InAs on GaAs," Phys. Rev. Lett. **78**, 4071 (1997).
14. W. Yu and A. Madhukar, "Molecular dynamics study of coherent island energetics, stresses, and strains in highly strained epitaxy," Phys. Rev. Lett. **79**, 905 (1997).
15. A. Nakano, M. Bachlechner, T. Campbell, R. Kalia, A. Omeltchenko, K. Tsuruta, P. Vashishta, S. Ogata, I. Ebbsjo, A. Madhukar, "Atomistic Simulation of Nanostructured Materials Using Parallel Multiresolution Algorithms," IEEE Computational Science & Engineering, **5**, 68 (1998).
16. A. Konkar, R. Heitz, T.R. Ramachandran, P. Chen, and A. Madhukar, "Fabrication of strained InAs island ensembles on nonplanar patterned GaAs (001) substrates," J. Vac. Sci. Technol. **B 16**, 3 (1998).
17. A. Konkar, A. Madhukar, and P. Chen, "Stress-engineered spatially selective self-assembly of strained InAs quantum dots on nonplanar patterned GaAs(001) substrates," App. Phys. Lett., **72,** 220 (1998).
18. T.R. Ramachandran, C. Baur, A. Bugacov, A. Madhukar, B. E. Koel, A. A. G. Requicha, and C. Gazen, "Direct and controlled manipulation of nanometer – sized particles using non-contact atomic force microscope," Nanotechnology, **9**, 237 (1998).
19. I. Mukhametzhanov, R. Heitz, J. Zeng, P. Chen, and A. Madhukar, "Independent manipulation of density and size of stress-driven self assembled quantum dots," Appl. Phys. Lett. **73**, 1841 (1998).
20. R. Heitz, I. Mukhametzhanov, P. Chen, and A. Madhukar, "Excitation transfer in self-organized asymmetric quantum-dot pairs," Phys. Rev. B **58**, R10151 (1998).
21. I. Mukhametzhanov, Z. Wei, R. Heitz, and A. Madhukar, "Punctuated island growth: an approach to examination and control of quantum dot density, size, and shape evolution," Appl. Phys. Lett. **75**, 85 (1999).
22. R. Heitz, I. Mukhametzhanov, O. Stier, A. Madhukar, and D. Bimberg, "Enhanced polar exciton- LO-phonon interaction in quantum dots," Phys. Rev. Lett., **83**, 4654 (1999).
23. R. Resch, C. Baur, A. Bugacov, B. E. Koel, P. M. Echternach, A. Madhukar, N. Montoya A. A. G. Requicha, and P. Will, "Linking and manipulation of gold and multinanoparticle structures using dithiols and scanning force microscopy," J. Phys. Chem. **B103**, 3647 (1999).
24. R. Resch, D. Lewis, S. Meltzer, N. Montoya, B. E. Koel, A. Madhukar, A. A. G. Requicha, and P. Will, "Manipulation of gold nanoparticles in liquid environments using scanning force microscopy," Ultramicroscopy, **82**, 135 (2000).
25. M. A. Makeev and A. Madhukar, "Simulations of atomic level stresses in systems of buried Ge/Si islands," Phys. Rev. Lett. **86**, 5542 (2001).

26. S. Meltzer, R. Resch, B. E. Koel, M. E. Thompson, A. Madhukar, A. A. G. Requicha, and P. Will, "Fabrication of Nanostructures by Hydroxylamine Seeding of Gold Nanoparticle Templates," Langmuir, **17**, 1713 (2001).
27. R. Resch, S. Meltzer, T. Vallant, H. Hoffman, B. E. Koel, A. Madhukar, A. A. G. Requicha, and P. Will, "Immobilizing Au nanoparticles on SiO2 surfaces using octadecylsiloxane monolayers," Langmuir, **17**, 5666 (2001).
28. E. T. Kim, Z. H. Chen, and A. Madhukar, "Tailoring detection bands of InAs quantum-dot infrared photodetectors using InxGa1-xAs strain-relieving quantum wells," Appl. Phys. Lett. **79**, 3341 (2001).
29. E. T. Kim, Z. Chen, and A. Madhukar, "Selective manipulation of InAs quantum dot electronic states using a lateral potential confinement layer," Appl. Phys. Lett. **81**, 3473 (2002).
30. A. Madhukar, "Stress Engineered Quantum dots: Nature's Way," in "Nano Optoelctronics: Concepts, Physics, and Devices," Ed. M. Grundmann, Springer-Verlag, (Berlin, 2002).
31. E. T. Kim, Z. H. Chen, M. Ho, and A. Madhukar, "Tailoring mid- and long-wavelength dual response of InAs quantum-dot infrared photodetectors using InxGa1-xAs capping layers," J. Vac. Sci. Technol. B **20**, 1188 (2002).
32. Z. Ye, J. C. Campbell, Z. H. Chen, E. T. Kim, and A. Madhukar, Voltage-controllable multi-wavelength InAs quantum-dot infrared photodetectors for mid- and far-infrared detection, J. Appl. Phys. **92**, 4141 (2002).
33. Z. Ye, J. C. Campbell, Z. Chen, E. T. Kim, and A. Madhukar, "Normal-incidence InAs self-assembled quantum-dot infrared photodetectors with a high detectivity," IEEE J. Quantum Electr. **38**, 1234 (2002).
34. X. Su, R. K. Kalia, A. Nakano, P. Vashishta, and A. Madhukar, "InAs/GaAs square nanomesas: Multimillion-atom molecular dynamics simulations on parallel computers," Jour. App. Phys., **94**, 6762 (2003).
35. Z. Ye, J. C. Campbell, Z. H. Chen, E. T. Kim, and A. Madhukar, "Noise and photoconductive gain in InAs quantum dot infrared photodetectors," App. Phys. Lett. **83**, 1234 (2003).
36. E. T. Kim, A. Madhukar, Z. Ye, and J. C. Campbell, "High performance quantum dot infrared detectors," App. Phys. Lett. **84**, 3277 (2004).
37. A. Konkar, S. Lu, A. Madhukar, S. M. Hughes, and A. P. Alivisatos, "Semiconductor nanocrystal quantum dots on single crystal semiconductor substrates: high resolution transmission electron microscopy," Nano Lett. **5**, 969 (2005).
38. A. Madhukar, S. Lu, A. Konkar, Y. Zhang, M. Ho, S. Hughes, and A. P. Alivisatos, "Integrated Semiconductor Nanocrystal and Epitaxical Nanostructure Systems: Structural and Optical Behavior," Nano Lett. **5**, 479 (2005).
39. S. Khatsevich, D. H. Rich, E. T. Kim, and A. Madhukar, "Cathodoluminescence imaging and spectroscopy of excited states in InAs self-assembled quantum dots," J. Appl. Phys. **97**, 123520 (2005).
40. S. Lu, A. Bansal, A. Madhukar, H. Lin, R. Datar, and R. Cote, "Simultaneous AFM & NSOM studies of quantum dot labeled cancer cells," MRS Spring Meeting, San Francisco, CA, April 2006.
41. S. Lu, A. Bansal, W. Soussou, T. W. Berger, and A. Madhukar, "Receptor-ligand based specific cell adhesion on solid surfaces: hippocampal neuronal cells on bilinker functionalized glass", Nano Lett. **6**, 1977 (2006).
42. S. Lu and A. Madhukar, "Nonradiative Resonant Excitation Transfer from Nanocrystal Quantum Dots to Adjacent Quantum Channels", Nano Lett., **17**, 3443 (2007).

43. S. Lu, J. K. Lee, Z. Lingley, M. H. Humayun, and A. Madhukar, “Optical Probing of Cell Physiological Changes under Stress”, BMES Annual Meeting Abstract (2007)
44. J. K. Lee, S. Lu, M. H. Humayun, A. Madhukar, “Real-Time Measurements of Multiple Intracellular Processes in Single Cells Under Stress” BMES Annual Meeting Abstract P.6.97 (2008)
45. T. Asano, A. Madhukar, K. Mahalingam, and G. J. Brown, “Dark current and band profiles in low defect density thick multilayered GaAs/InAs self-assembled quantum dot structures for infrared detectors” Jour. App. Phys. **104**, 113115 (2008)
46. S. Lu, Z. Lingley, T. Asano, D. Harris, T. Barwicz, S. Guha, and A. Madhukar, “Photocurrent induced by non-radiative energy transfer from nanocrystal quantum dots to adjacent silicon nanowire conducting channels: Towards a new solar cell architecture”, Nano Lett. **9**, 4548 (2009)
46. Jae Kyoo Lee, Siyuan Lu, Anupam Madhukar, "Observing cell death on the nanoscale: Real-time molecular imaging of retinal ganglion cell apoptosis under elevated pressure", Inaugural conference of the American Society for Nanomedicine (ASNM), Potomac, MD, October 22-25, 2009.
47. T. Asano, Z. Fang, and A. Madhukar, “Deep levels in GaAs(001)/InAs/InGaAs/GaAs self-assembled quantum dot structures and their effect on quantum dot devices “, Jour. App. Phys. **107**, 073111(2010)
48. S. Lu and A. Madhukar, **“**Cellular Prostheses: Functional Abiotic Nanosystems to Probe, Manipulate, and Endow Function in Live Cells”, Nanomedicine: Nanotechnology, Biology, Medicine, , **6,** 409 (2010)
49. J. K. Lee, S. Lu, and A. Madhukar, “Real-Time Dynamics of Ca2+, Caspase-3/7, and Morphological Changes in Retinal Ganglion Cell Apoptosis under Elevated Pressure”, PLoS One, **5,** e13437 (2010)
50. T. Asano, C.Hu, Y. Zhang, M. Liu, J. C. Campbell, and A. Madhukar, “Design Consideration and Demonstration of Resonant Cavity-Enhanced Quantum Dot Infrared Photodetectors in Mid Infrared Wavelength Regime (3 – 5 μm)”, IEEE Jour. Quantum Elec. **46**, 1484 (2010)
51 Z. Lingley, S. Lu, and A. Madhukar, “A High Quantum Efficiency Preserving Approach to Ligand Exchange on Lead Sulfide Quantum Dots and Interdot Resonant Energy Transfer”, Nano Lett. **11**, 2887 (2011).
52. S. Lu and A. Madhukar, “Inducing repetitive action potential firing in neurons via synthesized photoresponsive nanoscale cellular prostheses”, Nanomedicine: Nanotechnology, Biology, and Medicine **9**, 293–301 (2013)
53. Z. Lingley, K. Mahalingham, S. Lu, G. J. Brown, and A. Madhukar, “Nanocrystal–semiconductor interface: Atomic-resolution cross-sectional transmission electron microscope study of lead sulfide nanocrystal quantum dots on crystalline silicon”, Nano Research, **7,** 219 (2014).
54. Z. Lingley, S. Lu, and A. Madhukar, “The Dynamics of Energy and Charge Transfer in Lead Sulfide Quantum Dot Solids’, Jour. App. Phys. **115.** 084302 (2014)
55. J. Zhang, Z. Lingley, S. Lu, and A. Madhukar, “Nanotemplate-Directed InGaAs/GaAs Single Quantum Dots: Towards Single Photon Emitter Arrays”, Jour. Vac. Sc. Tech. **B32**, 02C106 (2014)

All Publications (A. Madhukar)

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