Monday, August 15, 2011

08:30 - 12:00

Nanoelectronics: Prospects and Challenges

Konstantin K. Likharev, *Stony Brook University*
klikharev@notes.cc.sunysb.edu

Abstract:
In the context of growing challenges to the exponential (“Moore’s-Law”) progress of integrated circuit technology, based mostly on CMOS scaling, I will review recent work on alternative nanoelectronic devices, circuits and architectures. Special emphasis will be made on hybrid semiconductor/ nanodevice integrated circuits which apparently may extend the Moore’s Law for approximately 10 to 15 years. In addition, mixed-signal and purely analog versions of the hybrid circuits may enable bio-inspired mixed-signal neuromorphic networks (“CrossNets”) which may be eventually capable of challenging the cortical circuitry in density and speed, at manageable power dissipation.

Biography:
Konstantin K. Likharev received the Candidate (Ph.D.) degree in Physics from the Lomonosov Moscow State University, Russia in 1969, and the habilitation degree of Doctor of Sciences from the Higher Attestation Committee of the U.S.S.R. in 1979. From 1969 to 1988 Dr. Likharev was a Staff Scientist of Moscow State University, and from 1989 to 1991 the Head of the Laboratory of Cryoelectronics of that university. In 1991 he assumed a Professorship at Stony Brook University (Distinguished Professor since 2002). During his research career, Dr. Likharev worked in the fields of nonlinear classical and dissipative quantum dynamics, and solid-state physics and electronics, notably including superconductor electronics and nanoelectronics. He is an author of more than 250 original publications, 75 review papers and book chapters, 2 monographs, and several patents. Dr. Likharev is a Fellow of the APS and IEEE. More detailed information is available online http://rsfq1.physics.sunysb.edu/~likharev/personal/

13:00 - 16:30

Graphene

Dr. Chagaan Baatar, *Office of Naval Research, Arlington Virginia*

In the present tutorial, an overview of the properties and applications of Graphene is presented. The tutorial will be organized more or less chronologically in terms of the major developments, surveys of some of the representative papers in the literatures, with an eye toward electronics application. Other aspects such as mechanical, chemical and thermal properties will also be covered briefly. The main outline is will be as follows:

- Summary of salient physical properties of graphene
- Summary of leading graphene synthesis methods
- More in-depth and up-to-date review of current literature on electronic properties of graphene, e.g. bandgap, mobility, graphene nanoribbons and edge structures etc
- Summary of other interesting properties of graphene and its derivatives
- Potential applications, e.g. electronics, optoelectronics, sensors, NEMS etc.
- Brief overview of some major graphene programs on-going in the US, e.g. DoD MURI programs and DARPA’s CERA program.

This tutorial is aimed at researchers and graduate students in EE, Physics, Material Science, and others who are new to the topic of graphene.

Biography:
Chagaan Baatar is a Program Officer at the Office of Naval Research in Arlington, Virginia, USA. He received his Ph.D. in condensed matter physics from University of Maryland in 1995. After postdoctoral appointments at MIT and IBM T. J. Watson Research Center, he was employed at Lucent Technologies Bell Laboratories as a Member of Technical Staff and worked on optical networking architecture design and optimization. Since 2003, Dr. Baatar has managed ONR's Nanometer Scale Electron Devices and Sensors program.

17:30 - 21:00 **Nanoelectronics and Modeling at the Nanoscale**

Dragica Vasileska, *Arizona State University, Tempe, Arizona*

Abstract:
Nanoelectronics refers to the use of nanotechnology on electronic components, especially transistors. Although the term nanotechnology is generally defined as utilizing technology less than 100 nm in size, nanoelectronics sometimes refers to transistor devices that are so small that inter-atomic interactions and quantum mechanical properties need to be studied extensively.

In this tutorial various effects that occur at the nanoscale will be reviewed. Emphasis will be placed on how different physical phenomena that occur at the nanoscale are successfully modeled. In that context bandstructure effects, choice of the proper transport kernels and coupling to efficient Poisson equation solvers will be discussed. The importance of Computational Electronics in the context of efficient design process of nanoscale devices and nanoscale structures in general, will be highlighted.

Biography:
Dragica Vasileska received the B.S.E.E. (Diploma) and the M.S.E.E. Degree from the University Sts. Cyril and Methodius (Skopje, Republic of Macedonia) in 1985 and 1992, respectively, and a Ph.D. Degree from Arizona State University in 1995. From 1995 until 1997 she held a Faculty Research Associate position within the Center of Solid State Electronics Research at Arizona State University. In the fall of 1997 she joined the faculty of Electrical Engineering at Arizona State University. In 2002 she was promoted to Associate Professor and in 2007 to Full Professor. Her research interests include semiconductor device physics and semiconductor device modeling, with strong emphasis on quantum transport and Monte Carlo particle-based simulations. She is a Senior Member of IEEE and a Member of APS. Dr. Vasileska has published more than 150 journal publications, over 80 conference proceedings refereed papers, 21 book chapters has given numerous invited talks and is a co-author on four books: D. Vasileska and S. M. Goodnick, Computational Electronics (Morgan and Claypool), D. Vasileska, S. M. Goodnick and G. Klimeck, Computational Electronics – Semiclassical and Quantum Transport Modeling (Taylor & Francis), D. Vasileska (Ed.) Cutting Edge Nanotechnology (In-Tech), D. Vasileska and S. M. Goodnick (Eds.) Semiclassical and Quantum Transport Modeling (Springer). She has many awards including the best student award from the School of Electrical Engineering in Skopje since its existence (1985, 1990). She is also a recipient of the 1998 NSF CAREER Award. Her students have won the best paper and the best poster award at the LDSD Conference in Cancun, 2004.

Monday, August 15, 2011

08:30 - 12:00 **Quantum Dots and Their Applications in Biology**

Joseph A. Bartel, *Life Technologies, Eugene, Oregon*

Abstract:

United States Federal funding for nanotechnology has increased from approximately $464 million in 2001 to nearly $1.5 billion for the fiscal year ending in 2009. In addition, private industry is investing an estimated $1.5 billion annually. Clearly, nanotechnology has captured the interest and imagination of industry and government alike. The diverse field of nanotechnology ranges from nanoscopic electronic devices to the development of targeted drug delivery solutions. Semiconductor nanocrystals, or quantum dots (QDs), are only a small piece of the nanotechnology investment but have already found significant commercial application in biology. This tutorial will introduce the basics of quantum dot physics and chemistry, and discuss specific technical challenges to commercialization, including the challenges associated with controlling nanostructures on the atomic level. The tutorial will conclude with a review of several current commercial biological applications of QDs including cellular and tissue imaging and medical diagnostics, as well as a discussion of new biological applications that are on the horizon.

Biography:

Joe Bartel serves as an R&D Senior Manager in Nanochemistry at Life Technologies Corporation. His recent research interests include development of robust synthetic processes to ensure sustainable manufacturability of nanomaterials and products related to labeling and detection. Joe is also interested in development of novel nanomaterials for new and emerging markets. Prior to joining Life Technologies, Joe Bartel was a scientist at Quantum Dot Corporation responsible for developing uniquely robust processes for the manufacture of quantum dots. Joe also held scientific positions at Xerox and Hewlett-Packard. Joe received a M.S. in Physical Chemistry from Washington State University under the direction of Professor Glen A. Crosby.

13:00 - 16:30 **Seeing at the “nm” and below**

Edgar Voelkl, *FEI*

Abstract:

Many concepts of our macroscopic world are based on light interacting with our environment and the interpretation of information perceived through our eyes. The “nm world” can be very different from the macroscopic world; and as we know, “light” has too long a wavelength to aid in its investigation. Thus electrons and ions have replaced photons; subsequently requiring new devices to cut, investigate, understand and ultimately control the “nm world” to our benefit.

Generally, photons, electrons and ions are particles or waves with rather unique and differentiating characteristics like mass, energy, or wavelength. Beginning with a review of the key models/concepts explaining interaction with the target, we will investigate resulting signals and their acquisition and interpretation. We will highlight specifically the latest developments in digital cameras that allow single electron detection and the latest development in energy dispersive X-ray microscopy – or short: the “super”-EDX detector.

Imaging components for electrons and ions also differ from optical lenses. While correction of lens aberrations including chromatic aberrations have enabled light microscopists to work at resolutions defined by the physical diffraction limit, electron microscopists are still very excited about the latest developments that allow them to work close to the 50mrad diffraction angle for the bargain price of a few million dollars. Given however a 0.05nm resolution in return, this may not be such a bad bargain. A close look will be taken at the latest developments in this area and the resulting images will likely speak for themselves.

Among the rather large number of methods available to microscopists, we will look at rather practical issues as cutting nm slices from bulk material but also at more exotic methods such as electron holography. The latter will specifically be highlighted partially because of its parallel development in light and electron optics as well as its specific capabilities to correct for aberrations and detecting electrostatic and magnetic fields with nm resolution.

IEEE NANO Conference - Tutorials: Track II

Monday, August 15, 2011

The capability of controlling structures at the nanometer scale and below is an essential pillar for our society. “Designed” materials are all around us. They helped America’s steel industry to survive and enabled a revolution in Egypt. The importance of the “nm” world has, undeniably, been growing and many jobs depend on it. Understanding the “nm world” is and will remain a key to our continued success.

Biography:

1991:	PhD in Physics on “High Resolution Electron Holography” from University of Tuebingen in Germany
1992 – 2001	R&D at the “Materials Analysis User Center” at the Oak Ridge National Laboratory
1997 – 2001	Adjunct Professor, Leigh University, Pennsylvania
2002	Program Chair for the annual Microscopy & Microanalysis meeting in Quebec, Canada
2001 – 2004	Corporate Fellow at nLine Corporation (semiconductor defect detection tool), Austin, TX ((after turning down an Endowed Chair position at Portland State University))*
2004	President of HoloWerk LLC (Business Development Consulting, e.g., Carl Zeiss, Imago Scientific Instruments; Software for off-axis type hologram acquisition and processing)
2007	Applications specialist and R&D at FEI Company

17:30 - 21:00 **Nanomaterials for Energy**

Sivaram Arepalli, *Department of Energy Science*
Sungkyunkwan University, Suwon, South Korea

Abstract:
This introductory tutorial is a broad overview of nanomaterials currently being used to provide short- and long-range solutions to energy issues. Production, storage and transmission of energy can be improved substantially by the use of nanomaterials. The first part of the tutorial will cover conventional methods of energy production, renewable energy sources, bio fuel cells, hydrogen storage, fuel cells, batteries, and supercapacitors. The second part will focus on conventional methods of energy transmission, smart grids, energy-efficient transportation and zero-energy buildings.

Biography:
Prof. Sivaram Arepalli has been with the Department of Energy Science at Sungkyunkwan University (SKKU) in Suwon, South Korea since 2009. Previously, he was the chief scientist of the applied nanotechnology program at NASA-Johnson Space Center in Houston, TX. His current interests include synthesis and processing of nanomaterials for energy applications, such as fuel cells, solar cells, batteries and supercapacitors, and nanocomposites for aerospace structures, environmental sensors and bio-implants. Prof. Arepalli is an Associate Fellow of AIAA and a senior member of APS. In 2008, he received the “Nanocarbon Award” from the Carbon Society of Japan. Prof. Arepalli has more than 80 publications and over 30 invited talks related to nanotechnology. He has conducted several nanotechnology based workshops and conferences, including the first International Green Energy Nanocarbon Conference in 2009. He currently serves as an associate editor for the “Journal of Nanoscience and Nanotechnology” (JNN) and as editor-in-chief for the “Journal of Nano Energy and Power Research” (JNEPR).

IEEE NANO Conference - Evening Plenary Session

Tuesday, August 16, 2011

19:30-21:00 **Introduction to nanoHUB.org – online simulation and more** Salon E/F

- George Adams III, Network for Computational Nanotechnology, Purdue University
- Krishna Madhavan, School of Engineering Education, Purdue University
- Dragica Vasileska, Victoria Farnsworth, Ira A. Fulton School of Engineering, Arizona State University
- Gerhard Klimeck, Network for Computational Nanotechnology, Purdue University

nanoHUB.org is funded by the National Science Foundation and supports the National Nanotechnology Initiative with a highly successful cyber-community for theory, modeling, and simulation, now serving 177,000 researchers, educators, students, and professionals annually. In the past 12 months nanoHUB users performed 348,000 nanotechnology simulations selecting from 214 programs. nanoHUB is the world's largest nanotechnology user facility.

There are over 200 simulation tools deployed on nanoHUB.org. These tools are supplemented by additional material such as first time user guides and classroom material such as homework or project assignments. Collections of tools and learning material are available for example in the "Semiconductor Device Education Material."

This workshop will begin with a short introduction into the history and driving force behind nanoHUB.org. It will then move into a high-level discussion around using nanoHUB.org and simulation in the classroom to enhance the achievement of learning objectives, closing with real-life teaching examples around diodes, MOS capacitors, bound states, formation of bands and Schred.

It will be beneficial for participants have an internet connected laptop computer including a standard web browser with Java and Flash installed. Participants who want to interactively follow along need to register at nanoHUB.org for a free login. This will take about 5 minutes and the participants are encouraged to register before the event at http://www.nanohub.org/register.

Presenters:

George B. Adams (gba@purdue.edu) is Deputy Director for nanoHUB.org. His background is in the design of high performance computers and algorithms. He joined the nanoHUB project in 2007 and has received three national awards for his teaching.

Krishna P.C. Madhavan (cm@purdue.edu) is an Assistant Professor in the School of Engineering Education at Purdue University and a member of the Education Research Team of the Network for Computational Nanotechnology. He specializes in the development, deployment, and assessment of advanced cybe-rinfrastructure tools in day-to-day engineering and science curricula. In January 2008, he was awarded the NSF CAREER award for work on transforming engineering education through learner-centric, adaptive cyber-tools and cyber-environments.

Dragica Vasileska (vasileska@asu.edu) is a Full Professor of Electrical, Computer and Energy Engineering at Arizona State University. She has published numerous papers in the area of nanoelectronics and semiconductor device modeling. She is an author of 2 texts and 2 edited books. She is a recipient of a NSF Career Award. Dragica Vasileska has made contributions to the nanoHUB since its inception. Her contributions have been used by more than 11,500 users.

Wednesday, August 17, 2011

19:30-21:00 **Nanoelectronics Manufacturability** Salon E/F

19:30-20:00 **Michael J Kelly,** Centre for Advanced Photonics and Electronics, University of Cambridge, UK

A simple theorem shows that a useful and manufacturable product will never be manufactured which relies on the addressing of 3nm diameter pixels on a 6nm pitch array[1]. The methods for making the array, whether by top-down or bottom-up techniques, will not deliver an adequate yield of sufficiently identical pixels, and even if it could, the uncontrolled interference between pixels would render the array inoperable. The practical interface between manufacturable and unmanufacturable artefacts probably takes place at nearer a 7nm half-pitch, which is where the statistics of small numbers first allows the area of features to achieve a 6σ uniformity.

There are many implications of this finding, the most significant being that many results in the literature[2], if not most, will never emerge from the laboratory into useful and commercial products. The bottleneck is manufacturability and a relatively greater effort is needed to demonstrate at an early stage all the prerequisites of manufacturability: a superior pre-specified performance with high yield to acceptable tolerance, reproducibility, uniformity, reliability and a simulator for both reverse engineering during development and right-first-time design. An increased and early focus on manufacturability will increase the end-to-end discovery-to-product efficiency of the R&D process.

M J Kelly, 'Intrinsic top-down unmanufacturability', Nanotechnology 22 234303 (2011)

[2]See http://www.eng.cam.ac.uk/~mjk1/102 CITATIONS.htm for a list of 102 such papers and their explicit statements on variability and/or reproducibility.

20:00-20:30 **Panel discussion**

Chair:

Jeffrey Morse, National Naomanufacturing Network (NNN), University of Massachusetts

Panel:

- Boyan Boyanov, Intel, Hillsboro OR
- Stephen Fonash, NSF National Nanotechnology Applications & Career Knowledge Center (NACK), Pennsylvania State University
- Yoon-Ha Jeong, Pohang University of Science & Technology, Korea

20:30-21:00 **Audience Q & A**