**IEEE Mini-Colloquium on Large Area Electronics**

**Friday, November 6, 2009**

**7.30AM – 6 PM EIT 3142**

**University of Waterloo, Waterloo, Canada**

**Agenda**

7.30 Light breakfast

7.55 Opening remarks

8.00 Distinguished Lecture #1: Lu Kasprzak, "Digital Radiography"

8.55 Invited Lecture #1: Safa Kasap "Progress in Science and Technology of Direct Conversion X-Ray Image Detectors: Competing Photoconductors and Selenium"

9.50 Coffee break

10.10 Distinguished Lecture #2: Yue Kuo "ULSI vs. TFT"

11.05 Distinguished Lecture #3: Ashraf Alam "The Physics and Technology of Nanonet Electronics"

12.00 Lunch break

2.10 Distinguished Lecture #4: Durga Misra "Breakdown of TiN/High-k Gate Stacks in Nanoscale CMOS"

3.05 Invited Lecture #2: Aldo Badano "Challenges and opportunities in modeling imaging detectors"

4.00 Coffee break

4.25 Invited Lecture #3: Ian Cunningham "Image Signal, Image Noise, and Why Some X-Ray Systems are Doomed to be Less Successful"

5.20 Closing remarks

5.30 Adjourn/lab tour

**Distinguished Lecture #1: Digital Radiography by Lu Kasprzak**

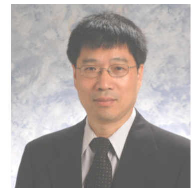
*Siemens Medical Solutions Diagnostics, Newark, USA*

Digital Radiography has become pervasive in the past 10 years. Image capture technologies and their applications will be reviewed, with a focus on TFT technology, fill factor, MTF, DQE, FPN and materials used.

*Biography: Lucian A. Kasprzak received the Ph.D. degree in Solid State Technology from the Materials Science Department of Stevens Institute of Technology in 1972, while on an IBM Resident Fellowship. He received a BS in Physics from Stevens in 1965 and an MS in Physics from Syracuse in 1970. He has worked, his entire career, on reliability of semiconductor devices and ICs: from their inception as discrete devices to ULSI. He discovered the hot electron effect in short channel MOSFET devices in 1973 while at IBM, from which he retired in 1995. The past 14 years, he has been in the medical device industry in various R & D organizations. He pioneered the creation of IEEE transactions on Device and Materials Reliability and is on the Board of Directors of the International Reliability Physics Symposium. Dr. Kasprzak is a Fellow of the IEEE.*

**Distinguished Lecture #2: ULSI vs. TFT by Yue Kuo**

*Dow Endowed Professor, Thin film micro and nanoelectronics research lab, Texas A&M University, Texas, USA*

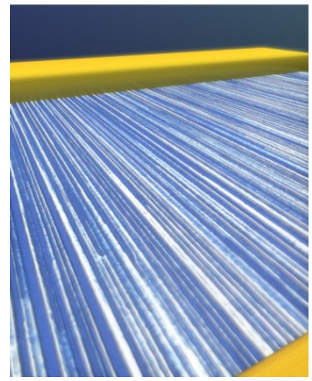


The sales of IC and TFT LCD products reached near US $300B and $80B, separately, recently. Currently, the state-of-the-art wafer size of IC is 12-inch while that of the TFT mother glass is great than 2 m by 2m. The mass production history of IC is 50 years while that of the large-size TFT array is 20 years. Therefore, both are highly successful industries. Recently, there are many new developments in the TFT technology that can broaden applications to beyond pixel driving but without losing the large-area fabrication capability. Furthermore, the new copper interconnect technology has been developed for both TFT and IC products. This is a good time to examine these two technologies and to explore their possible future developments. The speaker will analyze similarities and differences of these technologies and show examples on how they can learn from each other's experience and collaborate in developing future products.

*Biography: Yue Kuo is Dow endowed Professor in Texas A&M University. Previously, he served in IBM T. J. Watson Research Center and Silicon Valley for nearly 20 years. He established the renowned Thin Film Nano & Microelectronics Research Laboratory that is dedicated to ULSI and TFT research. He was awarded the 2007 Electronics and Photonics Award of the Electrochemical Society, 10 IBM technical and invention awards, IEEE Fellow, Electrochemical Society Fellow, etc. He has authored over 350 papers, edited 2 TFT textbooks, 3 journals, 15 proceedings, delivered 111 plenary/keynote/ invited speeches, and consulted industry and governments globally. His inventions have been widely used in industry. He received Dr. Eng. Sci. and MS from Columbia University and BS from National Taiwan University.*

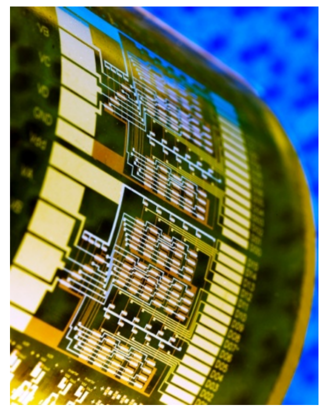
**Distinguished Lecture #3: The Physics and Technology of Nanonet Electronics by Muhammad A. Alam**

*School of Electrical and Computer Engineering, Purdue University, West Lafayette, Indiana*



**Abstract:** As the future of Moore's law of transistor scaling appears uncertain, Electronics is trying to reinvent itself by broadening its focus to other areas including macroelectronics (electronics of large, possibly flexible and transparent displays), bioelectronics (e.g., nanobio sensors for geomomics, proteomics), and energy-harvesting (e.g., solar cells). In this regard, a material based on nanonets of Carbon Nanotubes or Si/ZnO/SiGe Nanowires have attracted considerable attention. The nanonets act as channel materials for thin-film transistors for flexible/transparent electronics, as sensor elements for label-free bio-sensors, and as transparent top electrode for solar cells. The performance of these Nanonet devices have been good (and sometimes impressive) and various laboratories have reported considerable improvements over the years.

A lack of predictive transport models, however, has stymied the translation of laboratory experiments to practical, disruptive technology. The classical theory of bulk semiconductors, developed over last 50 years in close collaboration with experimentalists, device physicists, numerical analysts, and computer scientists, does no longer apply to these new electronic components with spatially inhomogeneous transport properties. In this talk, I will discuss a simple theory of the Nanonets based on 2D percolation and fractal dynamics to show how these simple/intuitive views is challenging conventional wisdom and allowing optimization of nanonet transistors, biosensors, and solar-cells.



***Biography:*** *MUHAMMAD ASHRAFUL ALAM is a Professor of ECE at Purdue University where his research and teaching focus on physics, simulation, characterization and technology of classical and novel semiconductor devices. From 1995 to 2001, he was with Bell Laboratories, Murray Hill, NJ, as a Member of Technical Staff in the Silicon ULSI Research Department. From 2001 to 2003, he was a Distinguished Member of Technical Staff at Agere Systems, Murray Hill, NJ. He joined Purdue University in 2004. Dr. Alam has published over 100 papers in international journals and has presented many invited and contributed talks at international conferences. He is a fellow of IEEE and APS and recipient of 2006 IEEE Kiyo Tomiyasu Award for contributions to device technology for communication systems.*

**Distinguished Lecture #4: Breakdown of TiN/High-k Gate Stacks in Nanoscale CMOS by Durga Misra**

*Electrical and Computer Engineering Department, New Jersey Institute of Technology, Newark, NJ 07102*

**Abstract**: Stringent power requirements in the chips by the International Technology Roadmap for Semiconductors (ITRS) dictate replacement of silicon dioxide as it has already reached the direct tunneling regime. Therefore, for high speed and low power applications high-k dielectric materials are being integrated into standard CMOS technologies. At present, reliability requirements of advanced gate stacks with high-k dielectrics are of intensive research interests as these high-k dielectrics needs to meet the silicon dioxide standards. In this talk some of the inherent asymmetry on breakdown characteristics of interfacial layer (IL) and high-κ layer in the overall gate stacks breakdown will be discussed. Gate stack's response to many degradation mechanisms such as charge trapping and defect generation, soft breakdown, progressive breakdown and finally hard breakdown will be evaluated as a function of ILs, grown on various process conditions. Correlation of stress-induced leakage current (SILC) with the breakdown behavior will be outlined.

***Biography****; Dr. Durga Misra is a Professor in the Department of Electrical and Computer Engineering of New Jersey Institute of Technology (NJIT). He received his M.S. and Ph.D. degrees both in Electrical Engineering from University of Waterloo, Waterloo, Canada in 1985 and 1988 respectively. He has been a faculty member since the fall of 1988 at NJIT. His current research focus is study of nanoscale CMOS gate stacks. He received several research awards from the National Science Foundation. In 1997 he worked at the VLSI Research Department at Bell Laboratories. He is currently a Distinguished Lecturer of Electron Device Society of IEEE and received IEEE Membership and Geographic Activities Board's International Leadership Award. He has organized many International Symposiums on Solid-State Science and Technology field during the Technical Meetings of the Electrochemical Society and IEEE. He is currently the "Circuits and Technology" track chair of International Conference in VLSI Design. At present, he serves as the EDS-SRC Chair for Regions 1-3 & 7 of IEEE. He is a Fellow of the Electrochemical Society (ECS) and is currently the Chair of Dielectric Science and Technology Division of ECS. He has co-edited several volumes on High-k gate stack ECS Transaction Series.*

**Invited Lecture #1: Progress in Science and Technology of Direct Conversion X-Ray Image Detectors: Competing Photoconductors and Selenium** *by Safa Kasap (University of Saskatchewan, Canada)*

Recently commercialized flat panel direct conversion x-ray mage detectors have been shown to provide high resolution x-ray imaging in which the resolution is limited by the underlying pixel size. The high resolution arises from the use of an x-ray photoconductor to convert the absorbed x-ray radiation directly to charge carriers. The key component of such an image detector is obviously the photoconductor. This talk reviews the past and present advances in x-ray photoconductors that enabled the eventual commercial production of the flat panel x-ray image detectors for medical imaging. A particular attention is paid to “selenium”, a curious semiconducting material that played an important and unusual role not only in early electrical engineering but in a number of diverse engineering applications, even today. The most important application of selenium is its use as a photoconductor in high resolution direct conversion x-ray imagers. One of the ultrasensitive modern video camera at NHK uses a photoconductive target based on avalanche multiplication in amorphous selenium - it can capture images even under candle light.

***Biography***: *Born in 1953, Safa Kasap grew up in London, England, and obtained a BSEE (1976), MSc (1978) and PhD (1983) from the Imperial College of Science and Technology at the University of London, specializing in optoelectronic materials and devices. In 2002, he was named a Canada Research Chair (Tier 1) in Electronic and Optoelectronic Materials and Devices at the University of Saskatchewan, a seven-year appointment, which has been renewed in 2009. In addition to two well-known textbooks on electronic materials and devices, and optoelectronics and photonics (with translations in Greek, Korean and Chinese), and numerous chapters in books, and books and encyclopedias and reviews, Safa Kasap has published more than two hundred articles in refereed international journals, as well as invited papers in a number of prestigious journals. Professor Kasap is currently involved in eight funded research projects supported by grants from NSERC and industry. His most important project is on enhancing the properties x-ray photoconductors for x-ray image detectors, and developing new models for these novel direct conversion detectors. His pioneering works in the last twenty years on a-Se alloys was responsible for the development of the x-ray photoconductor alloy material used in recently commercialized a-Se direct conversion x-ray image detectors for medical imaging; these detectors have shown to have the highest resolution. His research funds to date total over $11 million. He has supervised 23 MSc and 7 PhD theses and 19 PDFs and numerous research associates to date. Among Professor Kasap’s honours and awards received to date is a DSc in Engineering (1996) from the University of London, for his distinct contributions to materials science in electrical engineering. He is a Fellow of the Royal Society of Canada, the Canadian Academy of Engineering, the Engineering Institute of Canada, the American Physical Society, the Institution of Electrical Engineers (now the Institution of Engineering and Technology), the Institute of Materials (IOM3), the Institute of Physics, the Society for Glass Technology, and the Australian Institute of Physics. Recently, he was awarded a Fellow of the City and Guilds London Institute (FCGI) in the UK for his outstanding contributions to engineering education.*

**Invited Lecture #2: Challenges and opportunities in modeling imaging detectors**
*by Aldo Badano (Digital Imaging and Applied Math Division of the Food and Drug Administration, USA)*

The capability to simulate the imaging performance of new detector designs is crucial to develop the next generation of medical imaging systems. Proper modeling tools allow for optimal designs that maximize image quality while minimizing patient and occupational radiation doses. In this talk, I will review current progress and challenges in the simulation of imaging detectors with a focus on indirect columnar scintillator structures and on validation strategies.

**Invited Lecture #3: Image Signal, Image Noise, and Why Some X-Ray Systems are Doomed to be Less Successful** *by Ian Cunningham (University of Western Ontario Robarts Imaging Institute, Canada)*

Due to the health risks from exposure to radiation and the risks due to inconclusive or misleading diagnoses, x-ray imaging systems must produce high-quality images with the lowest possible dose to the patient. The characterization and optimization of detector performance and image quality involves understanding the physics of x-ray interactions and how these influence statistical properties of image signals and noise. It requires an understanding of how observers can extract non-random structures from random (and sometimes not random) image details. Finally, it requires an understanding of how observers are able to extract clinically meaningful information from the complicated clutter of background structural information. This talk will address some aspects of how far ìimage scienceî has come and where it may be going. It will highlight accomplishments that have become established in both academic and commercial fields, and problems that have not been solved. Hopefully, improved understanding of these issues will enable the development of better detectors and systems and improved patient outcomes.