Reliability / CPMT / ED Singapore Chapter

IEEE EDS Distinguished Lecturer Talk
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"Performance Evaluation of Nano Circuits and Systems with Ballistic Carriers"

Speaker : **Professor Vijay K. Arora**
Division of Engineering and Physics, Wilkes University, USA

Date : **22 June 2007, Friday**
Time : 10:30am – 11:30am
Venue : **IMRE Seminar Room 1**, 3 Research Link, Singapore 117602
Web : http://www.imre.a-star.edu.sg/contact/default.asp
http://www.imre.a-star.edu.sg/downloads.asp?File=OES%20-%20Vijay%20Arora%20220607.pdf
Admission : Free (Registration on-site)

ABSTRACT

Ohm's law, a linear current-voltage paradigm, has been and continues to be the basis for characterizing, evaluating performance, and designing integrated circuits. Its validity is under scrutiny as devices are scaled down to nanometer dimensions. In a macro-device of the twentieth century (typical size L = 1 cm), the critical voltage for triggering the nonohmic behavior, $V_c = (V_t/\ell_o)L$, was 3.7 kV for the room-temperature thermal voltage $V_t = k_B T/q = 26$ mV and an ohmic mean free path $\ell_o = 70$ nm for InGaAs, for example. In these *macro*-circuits, a 5-V logic voltage was well within the ohmic regime (V<<V_c). However, as we begin the twenty-first century, a typical device size, L, is in sub-0.1 μm regime and going smaller, with a critical voltage of 0.37 V or lower. In this *micro/nano*-circuit, even a low logic voltage of 1 V is above the critical voltage (V>>V_c). As dimensions are further scaled down to nanometer scale comparable to the de Broglie wavelength, quantum effects cannot be ignored and result in reduced dimensionality. The current is now controlled by ballistic velocity that is comparable to an appropriate thermal velocity for nondegenerate and Fermi velocity for degenerate systems for a given dimensionality. A quantum emission may lower the ballistic velocity. A review of the physics behind breakdown of Ohm's law and existence of quantum effects in engineering low-dimensional nanoelectronic devices is given. It will be shown how familiar voltage and current division laws, the transient phenomenon, and signal processing is affected in micro/nano-regime opening challenges and opportunities for tomorrow's physicists and nano-engineers.

ABOUT THE SPEAKER

Vijay K. Arora, a tenured Professor of Electrical Engineering and Engineering Management at Wilkes University, held distinguished visiting appointments at the University of Illinois, the University of Tokyo, National University of Singapore, Nanyang Technological University, the University of Western Australia, Universiti Malaysia Sabah, and Universiti Teknologi Malaysia. In addition to his long-term visiting appointments, Professor Arora has visited several international institutions on short-term consulting assignments and enjoys the privilege of knowing the cultures and educational methods being practiced around the globe. In recognition of his research, he is invited to give presentations at several international scientific gatherings. His research interests include mobility limiting mechanisms in high-speed devices, including quantum and high-field effects. Professor Arora has authored or co-authored over 150 papers on scientific and educational issues. As past chair of the International Division of American Society for Engineering Education (ASEE), he organized several international events. As chair of the 1996 ASEE Mid-Atlantic Conference, he edited and published the proceedings entitled *Re-Engineering Education and Training for a Competitive Global Economy*. He chaired NanoSingapore2006 that was held January 10-13, 2006 in Singapore. Professor Arora is on the Distinguished Lecturer Program of the IEEE Electron Devices Society and APS Forum on Industrial and Applied Physics. He is listed in *500 Greatest Geniuses of the 21st Century*, *Leading Educators of the World* 2005, *Leading Scientists of the World 2005*, *Great Minds of the 21st Century*, *Leading Intellectuals of the World, Millennium Hall of Fame*, *Five Thousand Personalities of the World*, *International Man of the Year 1998/99*, *Outstanding People of the 20th Century*, *International Who's Who of 20th Century Achievement*, *International Directory of Distinguished Leadership, Who's Who in the World, American Men and Women of Science*, *Who's Who in Science and Engineering*, *Who's Who in the East*, *Who's Who Among Asian Americans, Dictionary of International Biographies*, *Man of the Year—1996*, and *Most Admired Men and Women of the Year (1994-95)*.