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Reliability Issues in Current MOSFET and Beyond Silicon Technology

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Abstract

Modern integrated circuits (ICs) focused on lowering the size of semiconductor devices are quicker and more efficient thanks to the implementation of Moore's law at the nanoscale level. The successful scaling of silicon field-effect transistors in terms of power, performance, and cost has primarily driven the exponential growth of microelectronics over the last six decades. Nevertheless, this process is nearing its physical limitations as the critical dimensions of cutting-edge silicon devices approach the 5 nm zone. One of the main stumbling blocks to enhancing the device's performance is that MOSFETs have reliability concerns at the nanoscale. Reliability issues with silicon based MOSFET technology are a significant cause for worry in the nanoscale area. Thus, the integrated circuit manufacturing sector assumes that silicon devices would be unable to meet the needs of nanoscale technology to future perspective and demand. The miniaturization of MOS nanoscale semiconductor devices allows for more functionality and integration density per unit area without sacrificing performance. Due to their distinct geometrical and electrical features, carbon nanotubes (CNT) have been proposed as a viable alternative to silicon in the primary function of next-generation logic switches. This article first reviews the latest progress toward addressing the manufacturability issues for scaled carbon-nanotube transistors, from the material level up to the level of device integration and reliability concern. Then it compares these advantages to silicon from a technological development perspective. Lastly, potential future uses of nanotube transistors in the industry be proposed.

Keywords

MOSFET, Reliability, CNT, Carbon nanotube transistor, Technology Scaling.

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Biographies

S M Shakil received a B.S. degree in electrical and electronic engineering from the Dhaka University of Engineering and Technology, Gazipur, Dhaka, Bangladesh, in 2013. He is currently working toward an M.S. degree in electrical and computer engineering at Florida Polytechnic University, Lakeland, FL, USA, under the supervision of Dr. Muhammad S. Ullah. His current research interest focuses on MOSFET Reliability, Carbon Nanotubes for high-speed VLSI interconnects, and Field Effect Transistor. SM also worked on Wireless Power Transfer and Renewable Energy. He is a member of the IEOM Society International and a Graduate Student Member of the IEEE.

Dr. Muhammad Ullah, Ph.D. is an assistant professor of electrical and computer engineering at Florida Polytechnic University. His research focuses are the modeling of RLC interconnects in high density integrated circuits and energy-efficient electronic devices (TFET) for logic applications based on emerging 2-D nanomaterials (MoS2, Graphene, and CNT). He also worked on a neural network-based classification of deceptive and stress speech using non-linear spectral and cepstral features during his master's study. In his Ph.D. dissertation, he investigated the high-speed very-large-scale integration (VLSI)interconnect and energy-efficient electronic devices for emerging post-MOSFET and beyond silicon technologies. Before joining Florida Poly, Ullah worked as a full-time lecturer from 2008 to 2011 at the Chittagong University of Engineering & Technology (CUET), Bangladesh. From 2011 to 2013, he worked as a teaching assistant at Purdue University Northwest. He began working as a full instructor at the University of Missouri-Kansas City while he pursued his doctoral degree. He has taught undergraduate courses in electrical circuits, digital logic designs, signals and systems, and graduate courses in advanced digital signal processing, introduction to VLSI

designs, advanced VLSI designs, and emerging nanotechnology, including hands-on experience in MATLAB, Cadence Virtuoso, and HSPICE.

Ullah has served as a regular reviewer of many journals and conferences, including IEEE Transactions on very large-scale integration systems, IEEE International Symposium on Circuits and Systems, IEEE Midwest Symposium on Circuits and Systems, Microelectronics Journal-Elsevier and Circuits, Systems and Signal Processing-Springer, and ASP Journal of Low Power Electronics.