EDITORIAL

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Preface to the Special Issue on Beyond Moore: Resistive Switching Devices for Emerging Memory and Neuromorphic Computing

Yue Hao[1, †], Huaqiang Wu[2, †], Yuchao Yang[3, †], Qi Liu[4, †], Xiao Gong[5, †], Genquan Han[1, †], and Ming Li[6, †]

[1]School of Microelectronics, Xidian University, Xi'an 710071, China

[2]Institute of Microelectronics, Tsinghua University, Beijing 100084, China

[3]Department of Micro/nanoelectronics, Peking University, Beijing 100871, China

[4]Frontier Institute of Chip and System, Fudan University, Shanghai 200438, China

[5]Department of Electrical and Computer Engineering, National University of Singapore, Singapore 117546, Singapore

[6]Institute of Semiconductors, Chinese Academy of Sciences, Beijing 100083, China

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Traditional charge-based memories, such as dynamic random-access memory (DRAM) and flash, are approaching their scaling limits. A variety of resistance-based memories, such as phase-change memory (PCM), magnetic random-access memory (MRAM) and resistive random-access memory (RRAM), have been long considered for emerging memory applications thanks to their non-volatility, fast speed, low power, and compact size for potentially high-density integration. More recently, they are also extensively studied as memristors for neuromorphic computing, which has quite different requirements on their resistive switching characteristics compared to digital memory application. In the past decade, tremendous progresses, from materials and physical mechanisms to devices and neuromorphic systems, have been made to advance the field.

To capture the recent advancements and report the latest breakthroughs in this field, we organized a special issue on beyond Moore, which will be published in two consecutive issues on *Journal of Semiconductors*. The first one, focusing on resistive switching devices for emerging memory and neuromorphic computing, consists of five comprehensive review papers and three original research articles. Sokolov *et al.* provides a comprehensive review on the working mechanisms, materials, and engineering techniques of memristors for emerging memory and neuromorphic computing[1]. Yang *et al.* survey the *in situ* transmission electron microscopy studies on the switching mechanisms of nonvolatile memories and also their packaging reliability[2]. Besides two-terminal memristors, Huang *et al.* review the materials and working mechanisms of electrolyte-gated transistors as promising synaptic elements for high-performance neuromorphic computing[3]. Chen *et al.* revisit the advances in the hardware implementations of neural network accelerators and numerical computing units using memristor crossbar arrays[4]. Liao *et al.* review recent developments in neuromorphic vision sensors for highly efficient image processing by mimicking neuro-biological structures and functionalities of the retina[5]. In addition to those review articles, Gong *et al.* present an original research paper on the interesting short-term synaptic plasticity in ion-gel gated graphene synaptic transistors with electric double layer[6]. Shi *et al.* report the voltage-dependent plasticity, tuning from short-term plasticity to long-term potentiation, of tungsten oxide-based memristive synapses and further demonstrates the image Boolean operations in the memristive synapse array[7]. Tao *et al.* carry out in-depth studies on the neutron irradiation effect on the electrochemical metallization memory devices, showing excellent reliability performance against neutron irradiation[8].

We sincerely hope this special issue could provide a valuable overview and perspective on the developments of emerging memory and neuromorphic computing. We also hope the creative research articles in this special issue could inspire more research interest in this field to tackle the challenges towards future applications in memory and neuromorphic systems. We would like to thank all the authors for their outstanding contributions to this special issue. We are also grateful to the editorial and production staff of *Journal of Semiconductors* for their assistance.

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Correspondence to: Y Hao, yhao@xidian.edu.cn; H Q Wu, wuhq@tsinghua.edu.cn; Y C Yang, yuchaoyang@pku.edu.cn; Q Liu, qi_liu@fudan.edu.cn; X Gong, elegong@nus.edu.sg; G Q Han, gqhan@xidian.edu.cn; M Li, ml@semi.ac.cn

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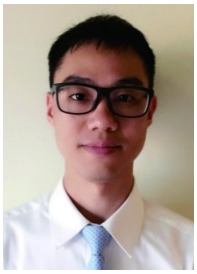
Yue Hao is currently a Professor of Microelectronics and Solid State Electronics with Xidian University, Xi'an, China. His current interests include wide and untra-wide bandgap materials and devices, advanced CMOS devices and technology, semiconductor device reliability physics and failure mechanism, and organic electronics. Prof. Hao is a senior member of IEEE and member of the Chinese Academy of Sciences.

Huaqiang Wu is presently the director of the department of microelectronics and nanoelectronics, and the director of the Institute of Microelectronics, Tsinghua University. Dr. Wu is also served as the deputy director of Beijing Innovation Center for Future Chips. Dr. Wu received his Ph.D. degree in electrical and computer engineering from Cornell University, Ithaca, NY, in 2005. Prior to that, he was a senior engineer in Spansion LLC, Sunnyvale, CA. He joined Tsinghua University in 2009. His research interests include emerging memory and neuromorphic computing technologies. Dr. Wu has published more than 100 technical papers and owns more than 90 US and China patents. Dr. Wu's papers have appeared on Nature, Nature Nanotechnology, Proceedings of the IEEE, IEEE EDL, ISSCC, IEDM, VLSI, etc.

Yuchao Yang received his PhD from Tsinghua University. He is now an Assistant Professor in Department of Micro/nanoelectronics and serves as Director of Center for Brain Inspired Chips at Peking University. His research interests include memristors, neuromorphic computing, and in-memory computing.

Qi Liu got his PhD degrees in microelectronics and solid-state electronics from the Anhui University in 2010. Now, he is a professor of Fudan University. Currently, his research interests focus on the fabrication, characterization and mechanism of the emerging memristor devices for nonvolatile memory, logic circuit and neuromorphic computing applications.



Xiao Gong is currently an Assistant Professor in the ECE Department of the National University of Singapore (NUS). He obtained his Ph. D Degree from NUS. He was also a Visiting Scientist at MIT in the year of 2014. His research interest includes advanced transistors for extremely low power logic and high frequency RF applications, emerging memories, circuits, and architectures for in-memory computing, single-photon avalanche diode for quantum technology, as well as 3D integration of hybrid devices for 5G/6G and optoelectronic integrated circuits.

Genquan Han received the B. Eng degree from Tsinghua University, Beijing, in 2003, and the Ph.D. degree from the Institute of Semiconductors, Chinese Academy of Sciences, Beijing, in 2008. He was a research fellow in National University of Singapore, from 2008 to 2013. In 2013, he joined College of Optoelectronic Engineering, Chongqing University. He is currently a Professor with the School of Microelectronics, Xidian University. His current research interests include high-mobility non-silicon MOSFETs, steep-slope field-effect transistors, novel non-volatile field-effect transistors, and Ga_2O_3 power devices. He is currently serving as an Editor for IEEE Electron Device Letters.

Ming Li Professor of the Institute of Semiconductors (IoS), CAS. He graduated from Shizuoka University in 2009. From 2009 to 2013, he engaged in postdoctoral research in the University of Ottawa and the INRS-EMT in Canada, and joined the IoS-CAS in 2013. He has been supported by the National Overseas High-level Youth Talent Program and the Excellent/Distinguished Young Scientist Foundation of NSFC. His research interests are mainly focused on optoelectronics and microwave photonics.