

# SYMPOSIUM ED2

Materials and Devices for Neuromorphic-Engineering  
and Brain-Inspired Computing  
April 18 - April 20, 2017

## Symposium Organizers

Ilya Karpov, Intel Corporation  
Barbara De Salvo, CEA-LETI  
Luping Shi, Tsinghua University  
Rong Zhao, Singapore University of Technology and Design

## Proceedings Statement

All authors are invited to submit articles based on their 2017 MRS Spring Meeting presentations to the journals in the MRS portfolio ([www.mrs.org/publications-news](http://www.mrs.org/publications-news)). Papers submitted and accepted for publication in MRS Advances ([www.mrs.org/mrs-advances](http://www.mrs.org/mrs-advances)) will be available as symposium collections. Visit the MRS/Cambridge University Press Publications Booth #100 in the Exhibit Hall to learn more, including MRS Advances print options available at special rates during the meeting week only.

\* Invited Paper

SESSION ED2.1: Neuromorphic System I  
Session Chairs: Jennifer Rupp and Luping Shi  
Tuesday Morning, April 18, 2017  
PCC North, 100 Level, Room 126 A

**10:30 AM \*ED2.1.01**  
**A Hybrid Neuromorphic Computing System with Advanced Learning Capabilities** [Karlheinz Meier](#); Heidelberg University, Germany.

**11:00 AM ED2.1.02**  
**HfO<sub>2</sub>-Based Devices for Neuromorphic Network with Real-Time Operation** [Stefano Brivio](#); IMM-CNR, Italy.

**11:15 AM ED2.1.03**  
**Organic and Organic-Inorganic Hybrid Artificial Synapses** [Tae-Woo Lee](#); Seoul National University, Korea (the Republic of).

SESSION ED2.2: Neuromorphic System II  
Session Chairs: Elisa Vianello and Jianhua Yang  
Tuesday Afternoon, April 18, 2017  
PCC North, 100 Level, Room 126 A

**1:30 PM \*ED2.2.01**  
**Designing Oxide Architectures and Charge Transfer Processes for Resistive Switching Memory and Computing Operations** [Jennifer L. Rupp](#); Massachusetts Institute of Technology, United States.

**2:00 PM ED2.2.02**  
**Pulse Characterization of HfO<sub>x</sub>-Based RRAM for Resistive Processing Unit Application** [Seyoung Kim](#); IBM, United States.

**2:15 PM ED2.2.03**  
**Pattern Recognition with “Materials that Compute”** [Yan Fang](#); University of Pittsburgh, United States.

**2:30 PM \*ED2.2.04**  
**Challenges and Solutions for Memristors Used for Memory and Neuromorphic Computing** [Jianhua J. Yang](#); University of Massachusetts Amherst, United States.

**3:00 PM BREAK**

**3:30 PM \*ED2.2.05**  
**Bioinspired Programming of Resistive Memory Devices for Implementing Embedded Neuromorphic Circuits** [Elisa Vianello](#); CEA Leti, France.

**4:00 PM ED2.2.06**  
**Li-Ion Synaptic Transistor for Low Power Analogue Computing (LISTA)** [Elliot J. Fuller](#); Sandia National Laboratories, United States.

**4:15 PM ED2.2.07**  
**Spatial Summation of Organic Artificial Synapses** [Yuandong Hu](#); Tsinghua University, China.

**4:30 PM \*ED2.2.08**  
**Oxide-Based Electric-Double-Layer Transistors for Neuromorphic Systems** [Qing Wan](#); Nanjing University, China.

SESSION ED2.3: Poster Session  
Session Chairs: Luping Shi and Rong Zhao  
Tuesday Afternoon, April 18, 2017  
8:00 PM - 10:00 PM  
Sheraton, Third Level, Phoenix Ballroom

**ED2.3.01**  
**Cause of RRAM Device Switching Variability and Its Impact on use in Neural Network Arrays** [Karsten Beckmann](#); State University of New York Polytechnic Institute, United States.

**ED2.3.02**  
**A Universal Logic-in-Memory Methodology to Implement Boolean Logic Based on Memristor** [Yaxiong Zhou](#); Wuhan National Laboratory for Optoelectronics, School of Optical and Electronic Information, Huazhong University of Science and Technology, China.

**ED2.3.03**  
**Mimicking Synaptic Processing from Ion Gel-Gated IGZO Transistors with Au Trapping Layers** [Jaemok Koo](#); Soonsil University, Korea (the Republic of).

**ED2.3.04**  
**Design of the Insulator-to-Metal Transition Properties in Vanadium Oxides for the Joule-Heating Devices** [Jianqiang Lin](#)<sup>1,2</sup>; <sup>1</sup>Argonne National Laboratory, United States; <sup>2</sup>University of Chicago, United States.

SESSION ED2.4: Electronic Synapse Design and Characterization  
Session Chair: Ilya Karpov  
Wednesday Morning, April 19, 2017  
PCC North, 100 Level, Room 126 A

**9:00 AM \*ED2.4.01**  
**Electro-Thermal Motion of Ions and Electronic Switching in Transition-Metal-Oxide Memristors** [R. Stan Williams](#); Hewlett Packard Enterprise, United States.

**9:30 AM ED2.4.02**  
**Interplay of Different Synaptic Plasticity Features in Electro-Chemical Metallization Cells** [Fabien Alibart](#); IEMN-CNRS, France.

**9:45 AM BREAK**

**10:15 AM \*ED2.4.03**  
**Neuromorphic Computing Based on Synaptic Device of Bi-Directional Analog Behavior** [Huaqiang Wu](#); Tsinghua University, China.

**10:45 AM ED2.4.04**  
**Transition between Short-Term Memory and Long-Term Memory in Artificial Electronic Synapses** [Yishu Zhang](#); Singapore University of Technology and Design, Singapore.

**11:00 AM ED2.4.05**  
**Analog Resistive Switching Emulating Biological Synaptic Behaviors in a Pt/CeO<sub>2</sub>/Pt Structures** [Hyung Jun Kim](#); Myongji University, Korea (the Republic of).

**11:15 AM \*ED2.4.06**  
**Oscillation Neuron Device Design Considerations** [Shimeng Yu](#); Arizona State University, United States.

SESSION ED2.5: Memristive Device and Its Material Fabrication/  
Characterization for Brain-Inspired Computing I  
Session Chairs: Duygu Kuzum and Huaqiang Wu  
Wednesday Afternoon, April 19, 2017  
PCC North, 100 Level, Room 126 A

**1:30 PM \*ED2.5.01**

**Memristor-Based Spiking Neuromorphic Networks** Dmitri Strukov;  
University of California, United States.

**2:00 PM ED2.5.02**

**Effect of Material Deposition Parameters on the Switching Dynamics of HfO<sub>2</sub>-Based Memristive Synapses** Jacopo Frascaroli; Laboratorio MDM, IMM - CNR, Italy.

**2:15 PM ED2.5.03**

**MBE Grown Volatile and Non-Volatile Memristors for Neuromorphic Computing** Marshall B. Tellekamp; Georgia Institute of Technology, United States.

**2:30 PM BREAK**

SESSION ED2.6/ED11.8: Joint Session: Devices for Neuromorphic  
Computation

Session Chairs: Daniele Ielmini and Shimeng Yu  
Wednesday Afternoon, April 19, 2017  
PCC North, 100 Level, Room 131 C

**3:30 PM \*ED2.6.01/ED11.8.01**

**The N3XT Technology for Brain-Inspired Computing** H.-S. Philip Wong;  
Stanford University, United States.

**4:00 PM ED2.6.02/ED11.8.02**

**Low Voltage Nano-Ionics Based Selector Devices Using Doped HfO<sub>2</sub> for Application in 3D Crosspoint Memories** Sushant S. Sonde<sup>1,2</sup>; <sup>1</sup>Institute for Molecular Engineering, University of Chicago, United States; <sup>2</sup>Argonne National Laboratory, United States.

**4:15 PM ED2.6.03/ED11.8.03**

**Finite Element Modeling of Ovonic Threshold Switch Controlled Phase Change Memory Devices** Jacob Scoggin; University of Connecticut, United States.

SESSION ED2.7: Memristive Device and Its Material Fabrication/  
Characterization for Brain-Inspired Computing II

Session Chairs: Barbara De Salvo and R. Stan Williams  
Thursday Morning, April 20, 2017  
PCC North, 100 Level, Room 126 A

**8:30 AM \*ED2.7.01**

**Image Analysis Using Memristor Networks** Wei D. Lu; University of Michigan, United States.

**9:00 AM ED2.7.02**

**Ferroelectric HfO<sub>2</sub> for CMOS-Compatible Synaptic Devices** Martin M. Frank; IBM T. J. Watson Research Center, United States.

**9:15 AM ED2.7.03**

**Imaging Dynamic Oxygen Vacancy Behaviour in a Memristive Device** Hua Zhou; Argonne National Laboratory, United States.

**9:30 AM BREAK**

SESSION ED2.8: Neuromorphic Devices, Sensors and Materials I

Session Chairs: Wei Lu and Qing Wan  
Thursday Morning, April 20, 2017  
PCC North, 100 Level, Room 126 A

**10:00 AM \*ED2.8.01**

**Experimental Demonstration of Image Learning in a Memristive Synaptic Network** Daniele Ielmini; Politecnico di Milano, Italy.

**10:30 AM ED2.8.02**

**Electrical Self-Oscillation in NbO<sub>x</sub> Film Devices for Neuromorphic Computing** Xinjun Liu; The Australian National University, Australia.

**10:45 AM ED2.8.03**

**Development of Empirical Charge Transfer Interatomic Potential to Simulate Switching Processes in HfO<sub>2</sub>-Based Devices** Kiran Sasikumar; Argonne National Laboratory, United States.

**11:00 AM ED2.8.04**

**Integrated Photonics and Superconducting Electronics for Massively Scaled Neuromorphic Computing** Jeffrey Shainline; National Institute of Standards and Technology, United States.

**11:15 AM \*ED2.8.05**

**Bio-Inspired Computing Leveraging the Non-Linearity of Magnetic Nano-Oscillators** Julie Grollier; CNRS/Thales, France.

SESSION ED2.9: Neuromorphic Devices, Sensors and Materials II

Session Chairs: Julie Grollier and Qing Wan  
Thursday Afternoon, April 20, 2017  
PCC North, 100 Level, Room 126 A

**1:30 PM \*ED2.9.01**

**Programming Synaptic Devices for Computational Efficiency and Robustness in Neuromorphic Systems** Duygu Kuzum; University of California, San Diego, United States.

**2:00 PM ED2.9.02**

**Light-Sensitive Quantum Dot Memristor with Bi-Directional and Wavelength-Dependent Conductance Control** Fabian Hartmann; Universität Würzburg, Germany.

**2:15 PM ED2.9.03**

**Implementation of Spiking Neural Networks for Pattern Recognition with Memristive Synapses** Yingpeng Zhong<sup>1,2</sup>; <sup>1</sup>Wuhan National Laboratory for Optoelectronics, School of Optical and Electronic Information, Huazhong University of Science and Technology, China; <sup>2</sup>Electrical and Computer Engineering Department, University of California Santa Barbara, United States.

**2:30 PM ED2.9.04**

**Mixed Conductor Memristor for Accelerated Neural Net Training** Kevin W. Brev; IBM, United States.