Jianhua (Joshua) Yang

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Employment Experience:

Professor, Aug. 2020
The Department of Electrical and Computer Engineering
Co-director, The Institute for the Future of Computing
University of Southern California

Professor, 2015-2020
The Department of Electrical and Computer Engineering
University of Massachusetts, Amherst

Principal Researcher, 2012-2015
Responsibility: Leading the materials and device team
Senior Researcher, Researcher, Research Associate (post-doctoral), 2007-2012
Hewlett-Packard Labs, Palo Alto, CA

Education:

Ph. D., M.S., Materials Science Program (multidisciplinary program with ECE, MSE, ME, Physics, Chemistry and Biology) 2007
University of Wisconsin – Madison
Advisor: Y. Austin Chang (Deceased, NAE)
Thesis: Engineering and Characterizing Nanoscale Multilayers for Magnetic Tunnel Junctions (MTJs)

B.S. Mechanical Engineering, 1997
Southeast University, Nanjing, China

Publications: https://scholar.google.com/citations?user=9Oaf_cUAAAAJ&hl=en)

Patents:

120 Granted patents (see detailed publication list) and **60** pending patents (documents available upon request) with USPTO**.** Two patents on MRAM were licensed by Intel for **millions of dollars** through UW-Madison and the patents on ReRAM/Memristor were **transferred** to memory manufacturers, National Labs and startup companies for product development. The patents at UMass on Machine Learning Accelerators led to a fast-growing startup company I co-founded in 2018. The startup, TetraMem Inc., focuses on developing hardware accelerators for AI/ML and has raised $60M so far.

Selected Invited Talks: (from **over 160** invited talks)

1. "Memristive Field-Programmable Analog Arrays (memFPAA)", **The 5th International Conference on Memristive Materials, Devices & Systems** Cambridge, MA, USA, Nov. 2022 **(Keynote)**
2. "Memristive Devices for Neuromorphic Computing", **NANOARCH 2022: 17th Acm International Symposium On Nanoscale Architectures,** 2022, online. **(Keynote)**
3. "Thousands of conductance levels in memristors monolithically integrated on CMOS", **Neuromorphic Materials, Devices, Circuits and Systems (NeuMatDeCaS)**, 2023, online. **(Keynote)**
4. "Computing with Memristive Devices and Arrays", 2021, **Distinguished Seminar at Northwestern University**, Evanston, IL.
5. "Memristive Devices for Neuromorphic Computing", 2022, **Distinguished Lecture at George Washington University**.
6. "ARL Artificial Intelligence Tech Forecasting virtual workshop", 2021, **Discussion Lead** of *Edge Computing*.
7. "AI-Devices to systems: Resistive Switching Materials and Devices for Bio-Inspired Computing", **2021 VLSI-TSA (short course)**, April 2021, Hsinchu, Taiwan.
8. "Memristive Devices for Bio-Inspired Computing", International **Union of Materials Research Societies – International Conference in Asia 2021** (IUMRS-ICA 2021) Oct. 2021, Jeju Island, Korea. **(Plenary)**
9. "Engineering Mobile Species in Resistive Switches for Computing", **The 3rd International Symposium on Memory Devices for Abundant Data Computing**, May 2021, Hong Kong. **(Plenary)**
10. "Memristive Materials and Devices for Neuromorphic Computing", **The 19th International Nanotech Symposium & Exhibition** (NANO KOREA 2021), Jul. 2021, KINTEX, Korea. **(Plenary)**
11. "Computing with memristive dynamics", **The first International Conference on Neuromorphic Computing (ICNC2021),** Oct. 2021, Wuhan, China. **(Keynote)**
12. "The fusion of digital and analog: Opening new horizons in ICT, AI, and IOT", **4th International Conference on Memristive Materials, Devices & Systems (MEMRISYS)**, Nov. 2021, Tsukuba, Japan. **(Keynote)**
13. *Nature Conference* on Neuromorphic Computing 2019, "*Tutorials on Neuromorphic computing*" (*J. Joshua Yang* UMass: Materials/Devices, *Bill J. Dally* Stanford: Architecture/Algorithms, *Simon Laughlin* U. Cambridge: Neuroscience), Beijing, China. **(Invited Tutorial)**
14. *Nature Conference* on Neuromorphic Computing 2019, "*Neuromorphic computing with dynamics of diffusive memristors*", Beijing, China. **(Invited Talk)**
15. *The IEEE International Electron Devices Meeting (IEDM)* 2019, San Francisco, USA. **(Invited)**
16. *APS 2020 March meeting* "Materials and devices for neuromorphic computing". **(Invited)**
17. *Gordon Research Conference on Multifunctional Materials and Structures* 2020, Ventura CA. **(Invited)**
18. *International Conference on Memristive Materials, Devices & Systems (MEMRISYS)* 2019, Dresden, Germany. **(Plenary)**
19. *Nature Conference* on Flexible Electronics-Visions of a Flexible Future 2018, Xi'an, China. **(Keynote)**
20. *International Conference on Neuromorphic Systems (ICONS)* 2018, Knoxville, TN. **(plenary)**
21. *MRS Spring meetings, 2014, 2017, 2020* **(invited talks)**; *MRS Fall meetings, 2014, 2015, 2016, 2017* **(Invited talks)**

22. *International Conference on Memristive Materials, Devices & Systems (MEMRISYS)* 2018, Beijing, China (2018). **(Keynote)**
23. *International Emergent Memory Symposium (IEMS)* 2018, Ji'an, China. **(plenary)**
24. *The 6th Memristor and Memristive Symposium* 2018, Budapest, Hungary. **(plenary)**
25. *International Conference on Memristive Materials, Devices & Systems (MEMRISYS)* 2017, Athens, Greece. **(Plenary)**
26. *International Symposium on Memory Devices for Abundant Data Computing* 2017, *Hongkong.* **(Plenary)**
27. *Advances in ReRAM: Materials and Interfaces* 2015, Crete, Greece. **(Keynote)**
28. *China Semiconductor Technology International Conference (CSTIC)* 2016, Shanghai, China **(Keynote)**
29. *The IEEE International Symposium on Circuits and Systems (ISCAS)* 2014, Melbourne, Australia. **(Keynote)**
30. *The 224th Electrochemical Society Meeting* 2013, *ULSI Process Integration Symposium.*, CA. **(Keynote)**
31. *Special Lecture, AirForce Research Lab*, Rome, NY (2013). **(Chief Scientist Lecture Series)**
32. *The 11th IEEE Non-Volatile Memory Technology Symposium (NVMTS)* 2011, Shanghai, China. **(Keynote)**

Academic Activities:

Associate Editor: *Science Advances* (AAAS)

Advisory Board:

- *Neuromorphic Computing and Engineering (IoP): Senior Advisory Panel*
- *ADVANCED INTELLIGENT SYSTEMS (Wiley): Executive Advisory Board*
- *ADVANCED MATERIALS TECHNOLOGIES (Wiley): International Advisory Board*
- *SMALL STRUCTURE (Wiley): International Advisory Board*
- *THE INTERNATIONAL CONFERENCE ON ELECTROCERAMICS: International Advisory Board*
- *The 3rd INTERNATIONAL CONFERENCE on EMERGING MATERIALS, TECHNOLOGIES AND APPLICATIONS FOR NON-VOLATILE MEMORY DEVICES: International Advisory Board*
- CIMTEC 2024 *ADVANCES IN MATERIALS AND DEVICES RESEARCH FOR DIGITAL, NEUROMORPHIC AND UNCONVENTIONAL COMPUTING*, *International Advisory Board*

Editorial Board: *SCIENTIFIC REPORTS, FRONTIERS IN NEUROSCIENCE, CHIP*

Conference Chairs: The 8th and 10th IEEE Nanotechnology Symposiums on "Emerging Non-volatile Memory Technologies" 2012, and "2D Devices and Materials" 2014, respectively;

Conference co-Chair: The IEEE International Conference on Future Computing, 2017, 2018, 2019.

Conference co-Chair: "The 3rd international conference on emerging materials, technologies and applications for non-volatile memory devices", Salsomaggiore Terme, Italy, June 2017.

Conference co-Chair: "The 5th International Conference on Memristive Materials, Devices & Systems" Cambridge, MA, USA, Nov. 2022

Symposium co-chairs:

1. “Non-volatile Memory” in The IEEE International Electron Devices Meeting (IEDM) 2014;
2. "Memristors" in the Electrochemical Society (ECS) Meeting, 2017;
3. “Ionics of memrsitor/resistive switches” in 21st Solid State Ionics (SSI), 2017;
4. “Memristive devices - from fundamentals to applications” in International Materials Research Congress (IMRC), 2017;
5. “Emerging Materials, Technologies and Applications for Non-volatile Memory Devices” in CIMTEC 2018;
6. “Oxide Memristors” symposium at the 236th ECS Meeting, (2019);
7. “Progress in Neuromorphic Computing Materials, Devices and Systems” symposium at MRS Fall Meeting (2020);
8. “Fundamental Mechanisms and Materials Discovery for Brain-Inspired Computing - Theory and Experiment” symposium at MRS Spring Meeting (2020).
9. “USC AI Futures Symposium: AI on the Edge”, LA, CA, USA (2023).

Program/technical committees:

1. The founder Chair of IEEE Neuromorphic Computing Technical Committee (2021- present)
2. The EMN Meeting on Surface and Interface, 2016
3. The IEEE International Electron Devices Meeting (IEDM), 2014, 2015.
4. 5th International Conference on Smart and Multifunctional Materials, Devices, Structures in CIMTEC 2016. (International Advisory Board)
5. The IEEE Silicon Nanoelectronics Workshop (SNW) 2014
6. The IEEE Non-Volatile Memory Technology Symposium (NVMTS). 2011-2017
7. The International Conference on Advances in Circuits, Electronics and Micro-electronics, 2018.
8. Elected officer, The IEEE Nanotechnology Council (SF and Bayarea) 2011-2014

Guest Editors for journal special issues:

- “Non-volatile memory based on nanostructures” (*NANOTECHNOLOGY* special issue, 2011);
- “Memristive and resistive devices and systems” (*APPLIED PHYSICS A*, 2011);
- “Solid-state Memristive Devices and Systems” (IEEE Journal on Emerging and Selected Topics in Circuits and Systems, 2015);
- “Memristive Materials and Devices” (*ADVANCED ELECTRONIC MATERIALS*, 2018);
- “Materials for Neuromorphic Computing” (*NANOTECHNOLOGY*, 2019);
- “Memory Devices and Technologies for the Next Decade” (*IEEE TRANSACTIONS ON ELECTRON DEVICES*, 2019).
- “Memristive Neuromorphics: Materials, Devices, Circuits, Architectures, Algorithms and Their Co-Design” (*FRONTIERS IN NANOTECHNOLOGY*, 2020).
- “2D materials for neuromorphic computing” (Neuromorphic Computing and Engineering, 2021).

- "Neuromorphic Computing: from materials to applications" (Advanced Materials, 2022)
- "Neuromorphic Computing" (The IEEE Electron Devices Magazine, 2022)
- "2D materials for Neuromorphic Computing" (Neuromorphic Computing and Engineering, 2022)
- "Neuromorphic Engineering/Computing" (Scientific Reports, 2023)

- **Winner of UMass Spotlight Scholar (2017).**
- **Nominee for Samuel F. Conti Faculty Fellowship Awards (2018).**
- **Oversea review expert of CAS (2018).**
- **NVMTS2019 Best poster award. (2019).**
- **UMass Amherst Distinguished Faculty Lecturer (2019).**
- **Best paper in *Advanced Materials Technologies* 2019, Wiley.**
- **UMass Chancellor's Medal (highest honor of UMass, 2020).**
- **Clarivate™ Highly Cited Researchers in the field of Cross-Field (2020, 2021).**
- **Founder Chair of IEEE Neuromorphic Computing Technical Committee. (2021)**
- **Top World Best Scientists in the Research.com list for 2022.**
- **Powell Faculty Research Award, Powell Foundation (2021).**
- **IEEE Fellow (2022).**
- **NAI Fellow (2023).**

Extramural grants awarded since joined academia in 2015:

1. J. Joshua Yang (PI), Q. Xia (co-PI), Memristor Crossbar Arrays For Analog and Neuromorphic Computing, Air Force Research Lab (AFRL), 1/25/2015-12/26/2018, $1,569,992 (Yang share $863,492)
2. J. Joshua Yang (PI), Analog Memristor Based Hybrid Computation Engine, IARPA, 03/1/2015 – 02/29/2016, $249,983
3. J. Joshua Yang (PI), Fundamental Material Research for Unconventional Computing, Hewlett-Packard Co, 03/01/2015-02/29/2016, $99,994
4. J. Joshua Yang (PI), Q. Xia (co-PI), Fundamental Material Research for Unconventional Computing, Hewlett-Packard Enterprise, 02/01/2016-01/31/2018, $75,000 (Yang share $41,250)
5. J. Joshua Yang (PI), Q. Xia (co-PI), Hybrid CMOS/Memristor Analog Co-Processor for Efficient, DARPA (subcontract through Sperodevices), 3/1/2016-12/10/2016, $44,939 (Yang share $24,716)
6. J. Joshua Yang (PI), Memristor device characterizations for Vector-Matrix Multiplication application, Sperodevices, 9/8/2015-1/18/2016, $8,220
7. J. Joshua Yang (PI), Q. Xia (co-PI), Memristor based non-volatile memory for embedded applications, Goodix Inc., 04/01/2017-3/31/2019, $400,000 (Yang share $220,000)
8. J. Joshua Yang (UMass, PI), Q. Xia (co-PI), Memristor-CMOS Analog Co-Processor for Efficient Computation of PDEs, DARPA (subcontract through Sperodevices), 5/1/2017-4/30/2020, $697,015 (Yang share $383,358)
9. J. Joshua Yang (PI), Selector Devices For Emerging Non-Volatile Memory, Western Digital, 07/20/2018-07/19/2020, $60,000.
10. J. Joshua Yang (PI), Q. Xia (co-PI), Memristor based non-volatile memory for embedded applications (Renew), Goodix Inc., 04/01/2019-3/31/2020, $399,627.

11. J. Joshua Yang (PI), Selector Devices For Emerging Non-Volatile Memory (Renew), Western Digital, 07/20/2019-07/19/2020, $60,000.
12. J. Joshua Yang (co-PI), Q. Xia (PI), Fully Integrated Memristor System for Neuromorphic and Analog Computing, AFRL, 01/01/2018-12/31/2021, $799,997 (Yang share $399,999)
13. J. Joshua Yang (PI), Q. Xia (co-PI), Material fundamentals of memristor for computing accelerators, TetraMem Inc., 04/30/2019-10/31/2021, $499,756.

Currently Active

14. J. Joshua Yang (PI), Brain-inspired networks for multifunctional intelligent systems in aerial vehicles, MURI/AFOSR, 06/01/2019-5/31/2024, $999,997.
15. J. Joshua Yang (PI), Q. Xia (co-PI), Hai Li (Co-PI) Collaborative Research: ASCENT: 3D memristor convolutional kernels with diffusive memristor based reservoir for real-time machine learning, NSF, 07/20/2019-07/19/2023, $1,300,000. (Yang share $450,000)
16. J. Joshua Yang (PI), Modeling Study of Memcapacitive Neural Network for Neuromorphic Computing, AFRL, 09/2022-09/2025, $600,000.
17. J. Joshua Yang (PI), Memristive material studies, Spectral Energies, LLC (prime: AFRL), 03/2022-03/2023, $139,984.
18. J. Joshua Yang (PI), Fundamental studies of resistance switching materials and processes, TetraMem Inc., 08/2022-08/2024, $334,286.

Pending

19. J. Joshua Yang, Thermodynamic Computing, Portland State University (Prime: NSF), 03/2023-02/2025, $72,000.
20. J. Joshua Yang, Center for Mathematical, Molecular, and Materials Foundations of Complementary Intelligence, Texas A&M University (Prime: NSF), 09/2023-08/2028, $1,800,000.
21. J. Joshua Yang, Mid-scale RI-1 (M1:IP): EMERGE: Emergent-Memory Open-Research Gateway for Exploration and Innovation (Preliminary proposal), Texas A&M University (Prime: NSF), 10/2023-09/2028, $4,000,000.
22. J. Joshua Yang (co-PI, PI: Mike Chen), ACED Fab: 3D memristor/CMOS Hybrid Field-programmable Analog Arrays for Signal Processing from RF to Baseband, NSF, 07/2023-06/2026, $600,000.
23. J. Joshua Yang (co-PI, PI: B. Mel), EFRI BRAID: Flexible and efficient learning through strongly biased memristor-based computing architectures, 08/2023-07/2027, $1,993,257.

Detailed lists:

- **>185 refereed papers**
- **120 Granted Patents**
- **>169 invited/keynote/plenary talks**
- **>40,000 citations**
  https://scholar.google.com/citations?user=9Oaf_cUAAAAJ&hl=en&oi=sra

Peer-reviewed papers (* indicates corresponding author**):**

Papers after joining Academia:
Journal papers

1. M. Li, H. Liu, R. Zhao, F. Yang, M. Chen, Y. Zhuo, H.Wang, C. Zhou, Y. Lin, and J. Joshua Yang*, "Imperfection-enabled van der Waals memristors", *NATURE ELECTRONICS* (invited review).
2. Q. Shao, Z. Wang, S. Fukami, D. Querlioz, Y. Zhou, **J. Joshua Yang**, Y. Chen, L. O. Chua, "Spintronic memristors for computing", *NATURE REVIEW PHYSICS* (2022, under review).
3. R. Midya, A. S. Pawar, D. Pattnaik, E. Mooshagian, P. Borisov, T. D. Albright, L. H. Snyder, R. S. Williams, **J. Joshua Yang***, A. B. Balanov, S. Gepshtein*, S. E. Savel'ev*, "Artificial transneurons emulate activity in different areas of brain cortex", *NATURE* (under review)
4. M. Rao, H. Tang, J. Wu, W. Song, M. Zhang, W. Yin, Y. Zhuo, F. Kiani, B. Chen, X. Jiang, H. Liu, H.-Y. Chen, R. Midya, F. Ye, H. Jiang, Z. Wang, M.Wu, M. Hu, H. Wang, Q. Xia, N. Ge, J. Li, **J. Joshua Yang***, "Thousands of conductance levels in memristors integrated on CMOS", *NATURE* 615, 823-829 (2023).
5. D. V. Christensen, et al. "2022 roadmap on neuromorphic computing and engineering" *NEUROMORPHIC COMPUTING AND ENGINEERING* **2**, 022501 (2022).
6. Y. Li, W. Song, Z. Wang, H. Jiang, P. Yan, P. Lin, C. Li, M. Rao, M. Barnell, Q. Wu, S. Ganguli, A. K Roy, Q. Xia*, **J Joshua Yang***, "Memristive field-programmable analog arrays for analog computing", *ADVANCED MATERIALS*, 202206648 (2022).
7. S. Kunwar, C. B. Somodi, R. A. Lalk, B. X. Rutherford, Z. Corey, P. Roy, D. Zhang, M. Hellenbrand, M. Xiao, J. L. MacManus-Driscoll, Q. Jia, H. Wang, **J. Joshua Yang**, W. Nie, A. Chen, "Protons: Critical Species for Resistive Switching in Interface-Type Memristors", *ADVANCED ELECTRONIC MATERIALS* **9**, 2200816 (2023).
8. S. Asapu, J. N. Pagaduan, Y. Zhuo, R. Midya, T. Moon, D. Gao, J. Lee, Q. Wu, M. Barnell, S. Ganguli, R. Katsumata, Y. Chen, Q. Xia, and J. Joshua Yang*, "Large remnant polarization in reliable W/HZO/W ferroelectric capacitors", *Frontiers in Materials* **9**, 969188 (2022).
9. Q. Shao, Z. Wang, **J. Joshua Yang***, "Efficient AI with MRAM" *NATURE ELECTRONICS* **5**, 67 (2022).

10. F. Kiani, J. Yin, Z. Wang, **J. Joshua Yang**, and Q. Xia, "A fully hardware-based memristive multilayer neural network", *SCIENCE ADVANCES* **7**, eabj4801 (2021).
11. Q. Xia, **J. Joshua Yang,** R. Midya, "The secret order of disorder", *NATURE MATERIALS* **21**, 134 (2022).
12. Y. Zhuo, R. Midya, W. Song, Z. Wang, S. Asapu, M. Rao, P. Lin, H. Jiang, Q. Xia, R. S. Williams, **J. Joshua Yang***, "A Dynamical Compact Model of Diffusive and Drift Memristors for Neuromorphic Computing", *ADVANCED ELECTRONICS MATERIALS* **8**, 2100696 (2021).
13. P. Yao, **J Joshua Yang*,** "Deep Learning", in "2021 Roadmap on Neuromorphic Computing and Engineering", *NEUROMORPHIC COMPUTING AND ENGINEERING* (2021).
14. M. Rao, W. Song, F. Kiani, S. Asapu, Y.Zhuo, R. Midya, N. Upadhyay, Q. Wu, M. Barnell, P. Lin, C. Li, Z. Wang, Q. Xia, **J Joshua Yang***, "Timing Selector: using transient switching dynamics to solve the sneak path issue of crossbar arrays", *SMALL SCIENCE* **2**, 2100072 (2021).
15. K. Yang, **J Joshua Yang*,** R. Huang*, and Y. Yang*, "Nonlinearity in Memristors for Neuromorphic Dynamic Systems" *SMALL SCIENCE* **2**, 2100049 (2022).
16. N. K. Upadhyay, T. Blum, P. Maksymovych, N. V. Lavrik, N. Davila, J. A. Katine, A. V. Ievlev, M. Chi, Q. Xia, **J Joshua Yang*,** "Engineering Tunneling Selector to Achieve High Non-linearity for 1S1R Integration", *FRONTIERS IN NANOTECHNOLOGY* **3**, 656026 (2021).
17. M. Lanza, R. Waser, D. Ielmini, **J. Joshua Yang** et al., *ACS nano* **15**, 17214 (2021).
18. W. Wang, W. Song, P. Yao, Y. Li, J. Van Nostrand, Q. Qiu, D. Ielmini, **J Joshua Yang***, "Integration and co-design of memristive devices and algorithms for artificial intelligence", iScience **23**, 101809 (2020).
19. Z. Wang, H. Wu, G. Burr, C. S. Hwang, K. L. Wang, Q. Xia* and **J. Joshua Yang***, "Resistive switching materials for information processing", *NATURE REVIEW MATERIALS* **5**, 173–195 (2020).
20. P. Lin, C. Li, Z. Wang, Y. Li, H. Jiang, W. Song, M. Rao, Y. Zhuo, N. K. Upadhyay, M. Barnell, Q. Wu, **J. Joshua Yang*** and Q. Xia*, "Three-dimensional memristor circuits as complex neural networks", *NATURE ELECTRONICS* **3**, 225–232 (2020).
21. Y. Zhang, Z. Wang, J. Zhu, Y. Yang, M. Rao, W. Song, Y. Zhuo, X. Zhang, M. Cui, L. Shen, R. Huang, **J. Joshua Yang*,** "Brain-inspired computing with memristors: Challenges in devices, circuits, and systems", *APPLIED PHYSICS REVIEW* **7**, 011308 (2020).
22. N. K. Upadhyay, W. Sun, P. Lin, S. Joshi, R. Midya, X. Zhang, Z. Wang, H. Jiang, J. H. Yoon, M. Rao, M. Chi, Q. Xia, **J. Joshua Yang*,** "A Memristor with Low Switching Current and Voltage for 1S1R Integration and Array Operation", *ADVANCED ELECTRONIC MATERIALS* **6**, 1901411 (2020).
23. X. Li, J. Tang, Q. Zhang, B. Gao, **J. Joshua Yang**, S. Song, W. Wu, W. Zhang, P. Yao, N. Deng, L. Deng, Y. Xie, H. Qian, H. Wu*, "Power-efficient neural network with artificial dendrites", *NATURE NANOTECHNOLOGY* **15**, 776 (2020).
24. Q. Xia, K. K. Likharev, D. B. Strukov, H. Jiang, T. Mikolajick, ... **J. Joshua Yang** et al., NANOTECHNOLOGY **32**, 012002 (2020).
25. T. Fu, X. Liu, H. Gao, J. E Ward, X. Liu, B. Yin, Z. Wang, Y. Zhuo, D. JF Walker, J Joshua Yang, J. Chen, D. R Lovley, J. Yao, "Bioinspired bio-voltage memristors", *NATURE COMMUNICATIONS* **11**, 1861 (2020).
26. C.Wang, S.Liang, S. Wang, P. Wang, Z. Li, Z. Wang, A. Gao, C. Pan, C. Liu, J. Liu, H. Yang, X. Liu, W. Song, C. Wang, X. Wang, K. Chen, Z. Wang, K. Watanabe, T.

Taniguchi, **J. Joshua Yang*** and Feng Miao*, "Gate-tunable van der Waals heterostructure for reconfigurable neural network vision sensor*"* SCIENCE ADVANCES **6**, eaba6173 (2020).

27. P. Yao, H. Wu*, B. Gao, J. Tang, Q. Zhang, W. Zhang, **J. Joshua Yang**, H. Qian, "Fully hardware-implemented memristor convolutional neural network", *NATURE* 577, 641 (2020).
28. J. H. Yoon, J. Zhang, P. Lin, N. Upadhyay, P.Yan, Y. Liu,* Q. Xia, and **J. Joshua Yang***, "A Low-Current and Analog Memristor with Ru as Mobile Species", *ADVANCED MATERIALS* **32**, 1904599 (2020).
29. X. Zhang, Y. Zhuo, Q.Luo, Z. Wu, R. Midya, Z. Wang, W. Song, R.Wang, N. K. Upadhyay, Y. Fang, F. Kiani, M. Rao, Y. Yang, Q. Xia, Q. Liu*, M. Liu*, and J. Joshua Yang*, "An artificial spiking afferent nerve based on Mott memristors for neurorobotics" *NATURE COMMUNICATIONS* **11**, https://doi.org/10.1038/s41467-019-13827-6 (2020).
30. H. Jiang, C. Li, P. Lin, S. Pi, **J. Joshua Yang**, Q. Xia, "Scalable 3D Ta:SiOx Memristive Devices" *ADVANCED ELECTRONIC MATERIALS* **5**, 1800958 (2019).
31. M. Rao, Z. Wang, C. Li, H. Jiang, R. Midya, P. Lin, D. Belkin, W. Song, S. Asapu, Q. Xia, and **J. Joshua Yang***, "Learning with Resistive Switching Neural Networks", *IEDM* **35.4**, 835-838 (2019, invited paper).
32. X. Zhang, Z. Wang, W. Song, R. Midya, Y. Zhuo, R.Wang, M. Rao, Q. Xia, **J. Joshua Yang***, Qi Liu*, and M. Liu*, "Experimental Demonstration of Conversion-based SNNs with 1T1R Mott Neurons for Neuromorphic Inference", *IEDM* **06.7** 134-137 (2019).
33. J. Tang, F. Yuan, X. Shen, Z.Wang, M. Rao, Y. He, Y. Sun, X. Li, W. Zhang, Y. Li, B. Gao, H. Qian, G. Bi, S. Song, **J. Joshua Yang*,** H. Wu*, "Bridging Biological and Artificial Neural Networks with Emerging Neuromorphic Devices: Fundamentals, Progress, and Challenges", *ADVANCED MATERIALS* **31**, 1902761 (2019, invited review).
34. Z. Wang, C. Li, P. Lin, M. Rao, Y. Nie, W. Song, Q. Qiu, Y. Li, P. Yan, J. P. Strachan, N. Ge, N. McDonald, Q. Wu, M. Hu, H. Wu, R. S.Williams, Q. Xia*, **J. Joshua Yang***, "In situ training of feedforward and recurrent convolutional memristor networks", *NATURE MACHINE INTELLIGENCE* **1**, 434 – 442 (2019).
35. W. Chen, C. Dou, K. Li, W. Lin, P. Li, J. Huang, W. Wei, J. Wang, C. Xue, Y. Chiu, Y. King, C. Lin, R. Liu, C. Hsieh, K. Tang, **J. Joshua Yang**, M. Ho, and M. Chang, "CMOS-integrated memristive non-volatile computing-in-memory for AI edge processors", *NATURE ELECTRONICS* **2**, 420 – 428 (2019).
36. W. Sun, B. Gao, M. Chi, Q. Xia*, **J. Joshua Yang*,** H. Qian, H. Wu*, "Understanding memristive switching via in-situ characterizations and device modeling", *NATURE COMMUNICATIONS* **10**, 3453 (2019).
37. R. Midya, Z. Wang, S. Asapu, X. Zhang, M. Rao, W. Song, Y. Zhuo, N. Upadhyay, Q. Xia*, and **J. Joshua Yang***, "Reservoir Computing using Diffusive Memristors", *ADVANCED INTELLIGENT SYSTEMS* **1**, 1900084 (2019, invited paper).
38. Z. Wang, C. Li, W. Song, M. Rao, D. Belkin, Y. Li, P. Yan, H. Jiang, P. Lin, M. Hu, J. P. Strachan, N. Ge, M. Barnell, Q. Wu, A. G. Barto, Q. Qiu, R. S. Williams, Q. Xia, and **J. Joshua Yang***, "Reinforcement learning with analogue memristor arrays", *NATURE ELECTRONICS* **2**, 115-124 (2019).
39. Q. Xia* and **J. Joshua Yang***, "Memristive crossbar arrays for bio-inspired computing", *NATURE MATERIALS* **18**, 309-323(2019).

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63. United States Patent USPTO US9,184,213, 2015, "Nanoscale switching device" **J. Joshua Yang,** D. B. Strukov, W. Wu.
64. United States Patent USPTO US9,184,382, 2015, "Memristive devices with layered junctions and methods for fabricating the same" M. D. Pickett, **J. Joshua Yang**, G. Medeiros-Ribeiro.
65. United States Patent USPTO US9,178,153, 2015, "Memristor structure with a dopant source" M. X. Zhang, **J. Joshua Yang**, R. S. Williams.
66. United States Patent USPTO US9,171,613, 2015, "Memristors with asymmetric electrodes" A. M. Bratkovski, **J. Joshua Yang**, S.-Y. Wang, M. Stuke.
67. United States Patent USPTO US9,165,645, 2015, "High-reliability high-speed memristor" F. Miao, **J. Joshua Yang**, J. P. Strachan, W. Yi, G. Medeiros-Ribeiro, R S. Williams.
68. United States Patent USPTO US8,982,601 B2, 2015, "Switchable junction with an intrinsic diode formed with a voltage dependent resistor" **J. Joshua Yang**, J. P. Strachan, J. Borghetti, M. D. Pickett.
69. United States Patent USPTO US9,224,949 B2, 2015, "Memristive elements that exhibit minimal sneak path current" **J. Joshua Yang**, M. X. Zhang, R. S. Williams.
70. United States Patent USPTO US9,257,645 B2, 2016, "Memristors having mixed oxide phases" **J. Joshua Yang**, M. X. Zhang, F. Miao.
71. United States Patent USPTO US9,293,200 B2, 2016, "Multilayer memory array" J. H. Nickel, G. Medeiros-Ribeiro, **J. Joshua Yang**.
72. United States Patent USPTO US9,331,278 B2, 2016, "Forming memristors on imaging devices" **J. Joshua Yang**, N. Ge, Z. Li, M. X. Zhang.
73. United States Patent USPTO US9,276,204 B2, 2016, "Memristor with channel region in thermal equilibrium with containing region" F. Miao, **J. Joshua Yang**, J. P. Strachan, W. Yi, G. Medeiros Ribeiro, R. Stanley Williams.
74. United States Patent USPTO US9,224,821 B2, 2015, "Customizable nonlinear electrical devices" M. X. Zhang, **J. Joshua Yang**, G. Medeiros Ribeiro, R. S. Williams.
75. United States Patent USPTO US9,478,738 B2, 2016, "High-reliability high-speed memristor" F. Miao, **J. Joshua Yang**, J. P. Strachan, W. Yi, G. Medeiros Ribeiro, R. S. Williams.
76. United States Patent USPTO US9,508,928 B2, 2016, "Nanochannel array of nanowires for resistive memory devices" S.-Y. Wang, **J. Joshua Yang**.
77. United States Patent USPTO US9,558,869, 2017, "Negative differential resistance device" **J. Joshua Yang**, M. Zhang, R. S. Williams.
78. United States Patent USPTO US9,847,124 B2, 2017, "Resistive elements to operate as a matrix of probabilities", M. Hu, J. P. Strachan, G. Ning, **J. Joshua Yang**.
79. United States Patent USPTO US9,847,378 B2, 2017, "Resistive memory devices with a multi-component electrode" X. Sheng, Y. Jeon, **J. Joshua Yang,** H. S. Cho, R. H. Henze.

80. United States Patent USPTO US9,776,400 B2, 2017, " Printhead with a number of memristor cells and a parallel current distributor" N. Ge, **J. Joshua Yang**, Z. Li.
81. United States Patent USPTO US9,701,115 B2, 2017, "Printheads having memories formed thereon" **J. Joshua Yang,** N. Ge, Z. Li.
82. United States Patent USPTO US9, 793,322 B2, 2017, "Apparatus having first and second switching materials" N. Ge, **J. Joshua Yang**, R. S. Williams, K. M. Kim.
83. United States Patent USPTO US9,793,473, B2, 2017 "Memristor structures" S. Y. Wang, **J. Joshua Yang**, M. M. Zhang, A. M. Bratkovski.
84. United States Patent USPTO US9,885,937 B2, 2018, "Dynamical optical crossbar array" **J. Joshua Yang**, A. M. Bratkovski, D. A. Fattal, M. Zhang.
85. United States Patent USPTO US9,870,822 B2, 2018, "Non-volatile memory element with thermal-assisted switching control" G. Ning, **J. Joshua Yang**, Z. Li.
86. United States Patent USPTO US9,947,405 B2, 2018 "Memristive dot product engine with a nulling amplifier" J. P. Strachan, G. E. Montgomery, N. Ge, M. Hu, **J. Joshua Yang**.
87. United States Patent USPTO US9,911,789 B2, 2018 "1-Selector n-Resistor memristive devices" **J. Joshua Yang,** G. Gibson, Z. Li.
88. United States Patent USPTO US9,911,490 B2, 2018 "Memory controllers" N. Ge, **J. Joshua Yang,** F. Perner, J. H. Nickel.
89. United States Patent USPTO US9, 889,659 B2, 2018 "Printhead with a memristor" N. Ge, **J. Joshua Yang,** M. Zhang.
90. United States Patent USPTO US9,934,852 B2, 2018 "Sensing an output signal in a crossbar array based on a time delay between arrival of a target output and a sneak output" K. M. Kim, N. Ge, **J. Joshua Yang**.
91. United States Patent USPTO US9, 911,915 B2, 2018 "Multiphase selectors" **J. Joshua Yang**, Y. Jeon, H. S. Cho.
92. United States Patent USPTO US9,934,849 B2, 2018 "Asymmetrically selecting memory elements" K. M. Kim, **J. Joshua Yang**, Z. Li.
93. United States Patent USPTO US9, 911,788 B2, 2018 "Selectors with oxide-based layers" **J. Joshua Yang**, Ning Ge, Zhiyong Li.
94. EP 2,842,163 B1, 2018 "Nonlinear memristors" **J. Joshua Yang**, M. Zhang, M. D. Pickett, R. S. Williams.
95. United States Patent USPTO US10, 026,896 B2, 2018 "Mutilayered Memristors" W. Jackson, **J. Joshua Yang**, K. M. Kim, Z. Li.
96. United States Patent USPTO US10, 026, 477 B2, 2018 "Selector relaxation time reduction" **J. Joshua Yang**, N. Ge, J. P. Strachan, G. Gibson, W. Jackson.
97. United States Patent USPTO US10, 026, 894 B2, 2018 "Memristors with oxide switching layer" N. Ge, **J. Joshua Yang**, M. Zhang, K. Samuels.
98. United States Patent USPTO US10, 008, 264 B2, 2018 "Memristor corss-bar array for determining a dot product" N. Ge, **J. Joshua Yang**, J. P. Strachan, M. Hu.
99. United States Patent USPTO US10, 056, 142 B2, 2018 "Generating a representative logic indicator of grouped memristors" N. Ge, **J. Joshua Yang**, Z. Li, R. S. Williams.
100. United States Patent USPTO US10, 076, 904 B2, 2018 "Integrated circuit devices comprising memristors" **J. Joshua Yang**, N. Ge, Z. Li.
101. United States Patent USPTO US10, 096, 651 B2, 2018 "Resistive memory devices and arrays" **J. Joshua Yang**, N. Ge, k. Samuels, M. Zhang.
102. United States Patent USPTO US10, 074, 695 B2, 2018 "Negative differential resistance (NDR) device based on fast diffusive metal atoms" **J. Joshua Yang**, R. S. Williams, M. Zhang, Z. Li.
103. United States Patent USPTO US10, 186, 660 B2, 2018 "Memristor device" Q. Xia, H. Jiang, **J. Joshua Yang**.
104. WO EP US KR TW TWI622989B, 2019, "Temperature compensation circuits" N. Ge, **J. Joshua Yang**, M. Hu, J. P. Strachan.

105. WO US TW TWI611403B, 2018, "A resistive random-access memory in printed circuit board" N. Ge, V. Nguyen, **J. Joshua Yang**, C. Hua, L. Warnes, D. B Fujii
106. WO US US20180075904A1, 2018, "Memristive crossbar array having multi-selector memristor cells" N. Ge, **J. Joshua Yang**, Z. Li, R. S. Williams
107. WO US US20180017870A1, "Dynamic logic Memcap" N. Ge, Z. Li, **J. Joshua Yang**, R. S. Williams
108. US10,181, 349 B2, "Nonvolatile memory cross-bar array" N. Ge, **J. Joshua Yang**, J. P. Strachan, M. Hu
109. US10, 643, 697 B2/US10, 109, 348, B2, "Double bias memristive dot product engine for vector processing" M. Hu, **J. Joshua Yang**, J. P. Strachan, N. Ge
110. US10, 147, 762 B2, "Protective elements for non-volatile memory cells in crossbar arrays" M. Zhang, **J. Joshua Yang**, R. S. Williams
111. US10, 580, 473 B2, "Memcapacitive cross-bar array for determining a dot product" N. Ge, J. P. Strachan, **J. Joshua Yang**, H. Miao.
112. EP2997597B1, 2018, "Nanochannel array of nanowires for resistive memory devices" S.-Y. Wang, **J. Joshua Yang**.
113. US10, 319, 441 B2, "Nonvolatile memory cross-bar array" N. Ge, **J. Joshua Yang**, J. P. Strachan, H. Miao.
114. US10, 325, 655 B2, "Temperature compensation circuits" N. Ge, **J. Joshua Yang**, H. Miao, J. P. Strachan.
115. US10, 262, 733 B2, "Memristive dot product engine for vector processing" **J. Joshua Yang**, H. Miao, J. P. Strachan.N. Ge.
116. US10,580,473 B2, "Memcapacitive cross-bar array for determining a dot product" **J. Joshua Yang**, N. Ge., J. P. Strachan, **J. Joshua Yang**, H. Miao.
117. US10, 741, 759 B2, "Diffusive memristor and device for synaptic emulator" **J. Joshua Yang**, Q. Xia, M. Mclean, Q. Wu, M. Barnell.
118. US10, 740, 672 B2, "Capacitive artificial neural networks" **J. Joshua Yang**, Q. Xia, Z. Wang, Q. Wu, M. R. Mclean.
119. United States Patent USPTO US11, 126, 403 B2, 2021 "True random number generator (TRNG) circuit using a diffusive memristor" **J. Joshua Yang**, Q. Xia, H. Jiang.
120. United States Patent USPTO US10, 970, 625 B2, 2021 "Device with multiple resistance switches with different switching characteristics" M. Hu, **J. Joshua Yang**, N. Ge.

Invited/Plenary/Keynote Talks:

International conferences:

1. *The 10th Non-volatile memory technology symposium (NVMTS09)* 2009, Portland, Oregon.
2. "Oxide based memristive nanodevices" 2009, **International Conference on Communications, Circuits and Systems 2009 (ICCCAS 2009)** San Jose, California.
3. "Metal/oxide/metal memristive devices" 2009, **The 7th International Conference on Advanced Materials and Devices (ICAMD)** 2009, Jeju island, KOREA.
4. "Engineering control and applications of oxide based nano-switches", 2010, **International Symposium on Integrated Functionalities (ISIF)** 2010, San Juan, Puerto Rico.
5. "Engineering control over device properties of memristors for immediate applications", **Julius Springer Forum on Applied Physics** 2010, Stanford University, CA.
6. "Promises and challenges of Memristive switches", **11th Non-Volatile Memory Technology Symposium** 2011, Shanghai, China. **(Keynote)**
7. "Oxide based memristive devices", **IEEE International Conference on Solid-State and Integrated Circuit Technology** 2012, Xi'an, China.
8. "TaOx based memristive devices", **12th Non-Volatile Memory Technology Symposium** 2012, Singapore.
9. "Memristive nanodevices for computing", **The 57th International Conference on Electron, Ion, Photon Beam Technology and Nanofabrication (EIPBN)** 2013, Tennessee.

10. "Memristive Devices for Computing", **The 224th Electrochemical Society Meeting** 2013, *ULSI Process Integration Symposium*, San Francisco, California. **(Keynote)**
11. "Memristive Nanodevices", **Nano and Giga** 2014, Phoenix, Arizona.
12. "Challenges and Materials Solutions for Memristive Devices (ReRAM)", **MRS Spring** 2014, San Francisco, California.
13. "The material perspective ReRAM" **The IEEE International Symposium on Circuits and Systems (ISCAS)** 2014**,** FEST 2014, Melbourne, Australia. **(Keynote)**
14. "Tutorial on Memristive devices" **the 29th Symposium on on Microeletronics Technology and Devices** 2014 *(SBMICRO 2014, Chip in Aracaju)*, Aracaju, Brazil.
15. "Challenges and solutions of memristors for Neuromorphic Computing" **the International Symposium on Neuromorphic Systems and Cyborg Intelligence** 2014, Hangzhou, China.
16. "Materials Perspective of Memristive Devices", **IEEE International Conference on Solid-State and Integrated Circuit Technology** 2014, Guilin, China**.**
17. "Challenges and Solutions for Memristive Devices", **The AVS 61st International Symposium & Exhibition** 2014, Baltimore, Maryland.
18. "RRAM tutorial", **MRS Fall Meeting** 2014, Boston, Massachusetts.
19. "Memristive Devices (ReRAM): Challenges and Possible Solutions", **MRS Fall Meeting** 2015, Boston, Massachusetts.
20. "Promises and challenges of memristive devices", **15th International Conference On Nanotechnology** 2015, **(IEEE Nano 2015),** Rome, Italy.
21. "Memristive nanodevices for computing - challenges and solutions", **China Semiconductor Technology International Conference 2015 (IEEE CSTIC 2015)** 2015, Shanghai, China.
22. "Challenges and possible solutions for memristive devices", **15th Non-Volatile Memory Technology Symposium (IEEE NVMTS 2015)** 2015, Beijing, China.
23. "Engineering interfaces for memristive devices", **the 43rd Conference on the Physics and Chemistry of Surfaces and Interfaces (PCSI-43)** 2016, Palms Springs, CA.
24. "Materials issues in memristive devices", **145th TMS annual meeting** 2016, Nashville, Tennessee.
25. "Different applications of memristors enabled by selector devices", **China Semiconductor Technology International Conference (CSTIC)** 2016, Shanghai, China. **(Keynote)**
26. **J. Joshua Yang**, "Memristor Mate devices", **International Workshop on Information Storage/10th International Symposium on Optical Storage (IWIS/ISOS 2016)** 2016, Changzhou, China. **(Keynote)**
27. "A versatile two-terminal device enables different applications of resistance switches" **The IEEE International Symposium on Circuits and Systems (ISCAS)** 2016, Montréal, Canada.
28. "Challenges and solutions for memristors used for memory and neuromorphic computing", **16th Non-Volatile Memory Technology Symposium (IEEE NVMTS 2016)** 2016, Pittsburg, Pennsylvania.
29. "Engineered materials for memristor mate" **International Conferences on Modern Materials and Technologies (CIMTEC)** 2016, Perugia, Italy.
30. "Engineered materials for memristor mate" **58th Electronic Materials Conference (EMC)** 2016, Newark, Delaware.
31. "non-volatile memories" **230th Meeting of Electrochemical Society (ECS)** 2016, Honolulu, Hawaii.
32. "Memristors with diffusive relaxation dynamics for neuromorphic computing", **IEEE 13th International Conference on Solid-State and Integrated Circuit Technology (ICSICT)** 2016, Hangzhou, China.
33. "Memristors with diffusive relaxation dynamics for neuromorphic computing" **16th Non-Volatile Memory Technology Symposium** 2016, Pennsylvania, USA.
34. "Emerging Materials and Technologies for Nonvolatile Memories", **MRS Fall Meeting** 2016, Boston, Massachusetts.
35. "Challenges and solutions for memristors used for memory and neuromorphic computing", **MRS Spring Meeting** 2017, Phoenix, Arizona.

36. "Challenges and solutions for memristors used for memory and neuromorphic computing", **Collaborative Conference on Materials Research (CCMR)** 2017, Jeju Island, South Korea.
37. "Diffusive memristors for future computing", **China Semiconductor Technology International Conference (CSTIC)** 2017, Shanghai, China. **(Keynote)**
38. "Diffusive Memristors*"* **1st International Conference on Memristive Materials, Devices & Systems (MEMRISYS)** 2017, Athens, Greece. **(Plenary)**
39. "Diffusive Memristors for Computing", **The 21st International Conference on Solid State Ionics (SSI-21)** 2017, Padua, Italy.
40. **"**RRAM/memristor for computing" **International Symposium on Memory Devices for Abundant Data Computing** 2017, Hongkong **(Plenary).**
41. "Diffusive Memristors as Artificial Synapses and Neurons for Neural Networks", **MRS Fall Meeting** 2017, Boston, Massachusetts.
42. "Diffusive memristor as an oscillatory neuron for brain inspired computing", **XXVI International Materials Research Congress** 2017, Cancun, Mexico.
43. "Bio-inspired computing with memristive devices", **Neurotalk** 2018, Bangkok, Thailand.
44. "Neuromorphic computing with memristive devices and arrays", **Compound Semiconductor Week (CSW2018)** 2018, MIT, Cambridge, USA.
45. "Diffusive memristor for computing", **The IEEE International Symposium on Circuits and Systems (ISCAS)** 2018, Florence, Italy.
46. "Diffusive Memristors for computing*"*, **International Conference on Memristive Materials, Devices & Systems (MEMRISYS)** 2018, Beijing, China. **(Keynote)**
47. "Neuromorphic computing with memristors", **Nature Conference** on Flexible Electronics-Visions of a Flexible Future 2018, Xi'an, China. **(Keynote)**
48. "Experimental demonstrations of unconventional computing with memristive devices", ***special session on memristors*** in the **International Conference on Neuromorphic Systems** 2018, Knoxville, Tennessee.
49. "Bio-inspired computing with memristive neural networks", **the International Conference on Neuromorphic Systems** 2018, Knoxville, Tennessee. **(plenary)**
50. "Memristive materials and applications", **The 3rd International Conference on New Material and Chemical Industry (NMCI)** 2018, Sanya, China (2018). **(Keynote)**
51. "Unconventional computing with memristive devices and arrays" **AiMES** 2018, Cancun, Mexico.
52. "Unconventional computing with memristive neural network", **China Semiconductor Technology International Conference (CSTIC)** 2018, Shanghai, China.
53. "Unconventional computing with memristive devices and arrays" **ACS Presidential Symposium** 2018**,** 256th ACS National Meeting, Boston, MA.
54. "Neuromorphic computing with memristive devices and arrays" **Solid State Devices and materials** 2018**,** Tokyo, Japan.
55. "Diffusive memristor for computing", **The 6th Memristor and Memristive Symposium** 2018, Budapest, Hungary. **(plenary)**
56. "Unconventional computing with resistive switching devices", **International Emergent Memory Symposium (IEMS-2018)** 2018, Ji'an, China. **(plenary)**
57. "Computing with memristive devices and arrays", **China Semiconductor Technology International Conference (CSTIC)** 2019, Shanghai, China.
58. "In Situ Learning with Memristive Neural Networks: Supervised, Unsupervised, Reinforcement", **International Nanodevices and Computer Conference (INC)** 2019**,** Grenoble, France.
59. "Memristive devices for brain-inspired computing", **15th IEEE International Conference on Electron Devices and Solid-State Circuits (IEEE EDSSC 2019)** 2019, Xi'an, China.

60. "In Situ Learning with Memristive Neural Networks: Supervised, Unsupervised, Reinforcement", **International Conference on Memristive Materials, Devices & Systems (MEMRISYS)** 2019, Dresden, Germany. **(Plenary)**
61. "Computing with memristive devices and arrays", **236th Meeting of the Electrochemical Society (ECS 2019),** Atlanta, Georgia**.**
62. "Tutorials on Neuromorphic computing", **Nature Conference on Neuromorphic Computing** 2019, Beijing, China. **(Invited Tutorial)**
63. "Neuromorphic computing with dynamics of diffusive memristors", **Nature Conference on Neuromorphic Computing** 2019, Beijing, China.
64. "Learning with Resistive Switching Neural Networks", **The IEEE International Electron Devices Meeting (IEDM)** 2019, San Francisco, USA.
65. "Materials and devices for neuromorphic computing", **APS March meeting** 2020, Denver, Co.
66. "Memristive materials and devices for unconventional computing", **MRS Spring meetings** 2020, Phoenix, Arizona.
67. "Memory Devices for Abundant Data Computing" **The 3rd International Symposium on** 2020, Hong Kong. **(Plenary)**
68. "Brain-inspired Neuromorphic Networks", **Gordon Research Conference on Multifunctional Materials and Structures,** Jan. 2020, Ventura CA.
69. "Computing with memristive devices and arrays", **The 6th International Conference on Electronic Materials and Nanotechnology for Green Environment (ENGE 2020)** Nov. 2020, Jeju, Korea.
70. "Memristive devices and arrays for neuromorphic computing", **The 13th IEEE International Conference on Solid-State and Integrated Circuit Technology (ICSICT),** Nov. 2020, Kunming, China.
71. "Memristive devices and arrays for neuromorphic computing", **The 11th International Green and Sustainable Computing Conference (IGSCC)**, Oct. 2020, online, USA.
72. "Memristive materials and devices for unconventional computing", **The 238th Meeting of The Electrochemical Society (ECS),** Oct. 2020, Honolulu, Hawaii.
73. "Resistive and capacitive crossbar arrays for neuromorphic computing", **Design Automation Conference (DAC) 2020**, Jul. 2020, San Francisco, California.
74. "Memristive materials and devices for unconventional computing", **The 78th Device Research Conference (DRC)**, Jun. 2020, Columbus, Ohio.
75. "Computing with memristive and memcapacitive devices", **MRS Fall meetings** 2020, Boston, Massachusetts.
76. "Memristive devices and arrays as AI hardware", **The 67th Annual AVS International Symposium (AVS67)** Oct. 2020, Denver, Colorado.
77. "AI-Devices to systems: Resistive Switching Materials and Devices for Bio-Inspired Computing", **2021 VLSI-TSA (short course)**, April 2021, Hsinchu, Taiwan.
78. "Memristive Devices for Bio-Inspired Computing", International **Union of Materials Research Societies – International Conference in Asia 2021** (IUMRS-ICA 2021, **Plenary**) Oct. 2021, Jeju Island, Korea.
79. "Engineering Mobile Species in Resistive Switches for Computing", **The 3rd International Symposium on Memory Devices for Abundant Data Computing**, May 2021, Hong Kong. **(Plenary)**
80. "Memristive Materials and Devices for Neuromorphic Computing", **The 19th International Nanotech Symposium & Exhibition** (NANO KOREA 2021), Jul. 2021, KINTEX, Korea. **(Plenary)**
81. "Memristive Devices and Arrays as AI Hardware", **The AVS 67th International Symposium & Exhibition** Oct. 2021, Charlotte, NC.

82. "Computing with memristive dynamics", **The first International Conference on Neuromorphic Computing (ICNC2021),** Oct. 2021, Wuhan, China. **(Keynote)**
83. "The fusion of digital and analog: Opening new horizons in ICT, AI, and IOT", **4th International Conference on Memristive Materials, Devices & Systems (MEMRISYS)**, Nov. 2021, Tsukuba, Japan. **(Keynote)**
84. "Memristive devices and arrays for computing", **The International Conference on Computer-Aided Design (ICCAD),** Workshop on Hardware and Algorithms for Learning On-a-chip, Nov. 2021, online.
85. "Memristive Devices and Arrays for Computing", **Electronic Materials and Applications (EMA) 2022,** Virtually.
86. "Neuromorphic Materials and Devices", **The International Conference on Neuromorphic Systems (ICONS)**, 2022, Knoxville, Tennessee.
87. "Neuromorphic computing with diffusive memristors", **The 2022 International Conference on Solid State Materials and Devices (SSDM 2022),** 2022, Chiba-city, Japan.
88. "Timing Selector: using transient switching dynamics to solve the sneak path issue of crossbar arrays", 2022 **The MRS Spring Meeting**, 2022, Honolulu, Hawaii.
89. The ENGE (**The International Conference on Electronic Materials and Nanotechnology for Green Environment**), 2022, Jeju, Korea.
90. "Memristive Devices and Arrays for Computing" **The 6th IEEE Electron Devices Technology and Manufacturing (EDTM) Conference**, 2022, Oita, Japan.
91. "Emerging memory for computing", **The 16th International Conference on Solid State and Integrated Circuit Technology (ICSICT 2022), 2022,** Nanjing, China.
92. "Memristive Field-Programmable Analog Arrays (memFPAA)", **The 5th International Conference on Memristive Materials, Devices & Systems** Cambridge, MA, USA, Nov. 2022 **(Keynote)**
93. "Memristive Materials and Devices for Unconventional Computing", **The 20th International Symposium on the Physics of Semiconductors and Applications (ISPSA)**, 2022, Jeju, Korea.
94. "Memristive Devices for Neuromorphic Computing", **NANOARCH 2022: 17th Acm International Symposium On Nanoscale Architectures,** 2022, online. **(Keynote)**
95. "Thousands of conductance levels in memristors monolithically integrated on CMOS", **Neuromorphic Materials, Devices, Circuits and Systems (NeuMatDeCaS)**, 2023, online. **(Keynote)**

International workshops:

96. The memristor at age 40", 2010, **International Symposium on Materials for Enabling Nanodevices**, UCLA, California. （**Plenary talk**）
97. "Applications and property engineering of memristive nanodevices", 2010, **Advances in nonvolatile memory materials and devices**, *Suzhou*, China.
98. "Recent progress on oxide based memristive devices in HP", 2011, **Non-volatile memories worshop**, University of California - San Diego, California.
99. "Oxide based memristive devices", 2011, **Frontier of Functional-Oxide Nano Electronics workshop,** Tsukuba, Japan.
100. "TaOx Memristive Nano-devices: Mechanism, Applications and Challenges", 2012, **Advanced Memory Workshop,** NCCAVS Thin Film Users Group, California.
101. "The Memristor" *LASERION international workshop*, 2013, Munich, Germany.
102. "Memristive Devices for Computing" **Global Forum on Nanoelectronic Manufacturing***: From Materials to Systems*, 2014 Mumbai, India.

103. "Memristive nanodevices for computing - challenges and solutions", **International workshop Advances in ReRAM:** *Materials and Interfaces 2015*, Crete, Greece. **(Keynote)**
104. "Experimental demonstration of analog computing and neuromorphic computing with memristor crossbar arrays" **Energy Consequences of Information Workshop**, 2017 Santa Fe, New Mexico.
105. "Unconventional computing using neural network based memristors", 2017, **The 2017 Stephen and Sharon Seiden Frontiers in Engineering & Science Workshop:** *"Beyond CMOS: From Devices to Systems"*, Haifa, Isreal.
106. "Memristive devices for neuromorphic computing", **the 2017 APS/CNM Users Meeting**, 2017, Argonne National Labs, Illinois.
107. "Experimental demonstration of analog computing and neuromorphic computing with memristor crossbar arrays", **2017 Energy Consequences of Information (ECI),** 2017, Santa Fe, New Mexico.
108. "Diffusive Memristor based Neural Networks", 2017, **International Workshop on Future Computing (IWoFC)**, Beijing, China. **(Keynote)**
109. "Challenges and possible solutions for RRAM based computing", 2017, **the 7th International Workshop on Resistive Switching Memory**, Leuven, Belgium.
110. "Opportunities and Challenges of Memristive Electroceramics for Computing", 2017, **Frontiers In Electroceramics Workshop**, MIT, Massachusetts.
111. "Resistive/memristive switching devices for computing", 2017, **IEEE-IRDS Beyond CMOS Workshop**, Albuquerque, New Mexico.
112. "Resistive and Capacitive Neural Networks Enabled by Diffusive Memristors", 2018, **International Workshop on Future Computing (IWoFC)**, Beijing, China. **(Keynote)**
113. "Artificial Synapses and Neurons Driven by Thermodynamics", 2019, **CCC Thermodynamic Computing workshop**, Honolulu, Hawaii. （**Plenary talk**）
114. "Computing with Memristive and Memcapacitive Devices", 2019, **Inaugural Chua Memristor Institute Conference (ICMIC 2019)**: Theory, Device, and Applications, Wuhan, China （**Plenary talk**）
115. "Materials challenges and solutions of memristive devices for computing", **NREL workshop on neuromorphic computing**, 2021, NREL, Denver.
116. "Engineering Memristors for Neuromorphic Computing", 2021, **The 17th IEEE International Workshop on Cellular Nanoscale Networks** (**CNNA 2021**), Catania, Italy.
117. "ARL Artificial Intelligence Tech Forecasting virtual workshop", 2021, Discussion Lead of Edge Computing.
118. "Neuromorphic computing enabled by diffusive memristors", **NAECON 2022 conference, special session on "Neuromorphic computing"**, 2022, Dayton, Ohio.
119. "Neuromorphic computing with diffusive memristors", **Advances in Bio-inspired and Neuromorphic Electronics,** Loughborough University, 2022, Loughborough, United Kingdom.
120. "Neuromorphic Computing with RRAM: challenges and potential solutions", **The 19th Annual IEEE Workshop on Microelectronics and Electron Devices (WMED 2022)**, 2022, Virtually.
121. "Self-powered and event-driven, sensing-processing system enabled by 3D memristor arrays", **Integrated Cognitive and Autonomous Multi-Sensor Systems Workshop**, 2022, TAMU.
122. "Memristive Devices for Neuromorphic Computing", **Collaborative workshop for accelerating intelligence semiconductor & AI**, 2022, GIST, Korea.
123. "Neuromorphic computing with diffusive memristors", **Excellence in Electronics** workshop hosted by **Advanced Electronic Materials** (Wiley), 2022, online.

Seminars:

124. "Resistance Memory Nanoelectronics", May/2009, *Invited Lecture*, **UCSC-NASA Ames Research Center**, Mountain View, California.
125. "Oxide based memristive junctions: switching, forming and device family", 2009, *Seminar*, **University of California, Santa Cruz**, California.
126. Seminar, 2009, Seoul National University, Korea.
127. "Memristive Nanodevices", 2010, *Seminar*, **Peking University**, Beijing, China.
128. "Oxide based nanoswitches", 2010, *Seminar*, **Chinese Academy of Science**, Beijing, China.
129. "Memristors in Computing: Promises and Challenges", 2011, *seminar*, **IEEE Computer Society**, San Jose California.
130. "Metal oxide based nonvolatile memories - promises and challenges", 2011, **IEEE Electronic Device Society**, Santa Clara, California.
131. "Memristive Nanodevices: mechanism, promises and challenges", 2012, *Seminar*, **University of Pittsburgh**, Pittsburgh, Pennsylvania.
132. "Oxide based Memristive Nanodevices", 2012, *Seminar*, **Michigan State University**, East Lansing, Michigan.
133. "Mermistor technology development", 2012, *seminar*, **Finisar corp**. Sunnyvale California.
134. "Memristive Nanodevices: Mechanisms, Applications and Challenges", 2012, **IEEE SINGAPORE REL/CPMT/ED CHAPTER**, Singapore.
135. "Memristive Devices for Computing", 2013, **IEEE SCV Electron Devices Society**, Santa Clara, California.
136. "Memristive nanodevices: mechanisms, promises and challenges", 2013, *seminar*, **University of California, Berkeley**, California.
137. *Special Lecture*, **AirForce Research Lab**, Rome, New York (2013). **(Chief Scientist Lecture Series)**
138. "Memristive materials and Devices", 2014, *Seminar*, **Tsinghua University**, Beijing, China.
139. "Resistance switching: applications, mechanisms and challenges", 2015, *Seminar*, **HGST**, San Jose, California.
140. "Challenges and solutions for memristors used for memory and neuromorphic computing", 2016, seminar, **Chinese Academy of Science**, Beijing.
141. "Memristor applications enabled by selectors", 2016, seminar, **Tsinghua University**, Beijing.
142. "Diffusive memristor as synaptic emulators for neuromorphic computing", 2016, seminar, **Peking University**, Beijing.
143. "Memristors for computing", 2017, seminar, **Huazhong University of Science and Technology**, Wuhan, China.
144. "Memristive devices for computing: applicsations, challenges and possible solutions", 2017, seminar, **SUSTC**, Shenzhen, China.
145. "Memristive devices for computing", 2017, Micro-Nano Seminar Series, **MIT**, Cambridge.
146. "Bio-inspired computing with memristors" 2018, **Zhengzhou University**, Zhengzhou, China.
147. "Unconventional computing with memristors" 2018, **Peking University**, Beijing, China.
148. "Bio-inspired computing with Memristor" 2018, Brain and Intelligence summer school of **Tsinghua University**, Beijing, China.
149. "Unconventional computing with memristive devices and arrays", 2018, Northwestern MRSEC Seminar, **Northwestern University**, USA.
150. "Unconventional computing with memristive devices and arrays", 2018, **NIST**, Gaithersburg, Maryland.

151. "Neuromorphic computing with memristor crossbar arrays", 2018, Applied Physics colloquium, **Harvard University**, Cambridge.
152. "Bio-inspired computing with memristive devices", 2018, MechE Colloquium, **MIT**, Cambridge.
153. "Challenges and Opportunities for Memristive Devices Used for Bio-inspired Computing", 2019, **AirForce Rsearch Labs (AFRL)**, Dayton, Ohio.
154. "Bio-inspired Computing with Memristive Devices", 2019, Neuromorphic Computing Forum, **Samsung**, Korea.
155. "Neuromorphic Computing with Memristive Devices", 2019, **Oak Ridge National Lab (ORNL)**, Oak Ridge, Tennessee.
156. "Computing with Memristive Devices and Arrays", 2021, Frontiers in Materials Lecture Series at **Pacific Northwest National Laboratory (PNNL)**, Richland, Washington.
157. "Computing with Memristive Devices and Arrays", 2021, **Distinguished Seminar at Northwestern University**, Evanston, IL.
158. "Memristive Materials for Computing", Quantum Materials and Devices Seminar, 2021, **Harvard University**, Cambridge.
159. "Memristive devices for computing" monthly colloquium of the Collaborative Research Center 1461 on Neurotronics_Bio-inspired Information Pathways, **Kiel,** Germany
160. "Memristive Materials and Devices for Neuromorphic Computing", 2021, Materials for the Future Seminar Series, **National University of Singapore.**
161. "Neuromorphic Computing with Memristive Devices", 2021, **IEEE MTTS/PHOS seminar**.
162. "Memristive Devices for Neuromorphic Computing", 2022, **Distinguished Lecture at George Washington University**.
163. "Memristive Devices for Neuromorphic Computing", 2022, **Group of Global Excellence seminar** (ECE department) at **Seoul National University**.
164. "Memristive Devices for Neuromorphic Computing", 2022, Seminar of the department of materials science and engineering, **Seoul National University**.
165. "Memristive Devices for Neuromorphic Computing", 2022, **University of Texas**, Arlington.
166. "Memristive Devices for Neuromorphic Computing", 2022, **Nanyang Technological University**, Singapore.
167. "Memristive Devices for Computing", 2022, **CFN Colloquium,** Brookhaven National Lab.
168. "Memristors as the future semiconductor devices for AI/ML", 2023**, Jeonbuk National University.**