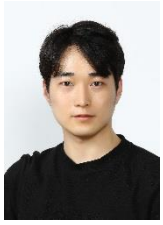
Ph.D. Seonghoon Jang (장성훈)



KU-KIST Graduate School of Converging Science & Technology
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RESEARCH INTERESTS

I have analyzed the resistive switching phenomena by controlling defect and doping concentration of various materials such as transition metal oxides, semiconductor oxides, organic materials, and 2D materials. And I have developed next generation memory devices and neuromorphic devices (artificial synapse) for artificial intelligence application. And I also studied CNN-based deep learning networks as intern at Korea Institute of Science and Technology, Korea National Research Institute.

EDUCATION

KU-KIST Graduate School of Converging Science and Technology, KOREA UNIVERSITY Seoul, Korea

M. S. in Nano Bio Information Technology February 2018

Ph. D. in Nano Bio Information Technology August 2022

KU-KIST graduate school is a graduate school with the aim of promoting interdisciplinary research, and I have collaborated with other laboratories and accomplished many research results including three co-first author papers, many co-author papers and patent applications.

With trained for interdisciplinary research, I have taken several classes about electronics and materials science such as ‘nano semiconductor physics and devices’, ‘electronic devices and circuits’, ‘next generation memory devices and storage systems’, and ‘research in oxide-based memory’.

College of Science, KOREA UNIVERSITY Seoul, Korea

B. S. in Physics February 2016

- won the KU Rock Foundation scholarship, 1st semester, 2014
- won the Study Scholarships, 2nd semester, 2013

I learned the background for physics including classical mechanics, electromagnetics, modern physics, quantum mechanics, optics, and solid-state physics, and conducted various physics experiments. In particular, I won the Study Scholarship for 2nd semester of 2013, and the KU Rock Foundation scholarship for 1st semester of 2014.

RESEARCH CAREER

Korea Institute of Science and Technology Seoul, Korea

Sensor System Research center From April 2018 to January 2019

From 1 April 2018 to 31 January 2019, I have worked as research intern at Korea Institute of Science and Technology, Korea's first government-affiliated research institute, and participated in project for Pen-side diagnostic technologies for veterinary diseases of nation-wide damage. I have developed a CNN-based deep learning network system to automatically diagnose disease infections and virus types. Through this, I was able to learn basic understanding of artificial intelligence and flow of information processing

Samsung electronics Suwon, Korea

Samsung Advanced Institute of Technology (SAIT) From August 2022 to today

- won the Samsung Electronics Industry-University Scholarship, 2020

Since August 2022, I have worked as researcher at beyond silicon lab at Samsung Advanced Institute of Technology (SAIT).

PUBLICATIONS (Co-1st Author)

1. Synaptic Barristor Based on Phase-Engineered 2D Heterostructures

W. Huh, S. Jang, J. Y. Lee, D. Lee, D. Lee, J. M. Lee, H.-G. Park, J. C. Kim, H. Y. Jeong, G. Wang*, and C-H. Lee*

Adv. Mater. **2018**, 30, 1801447 17 July 2018 IF: 25.81

Co-First Authorship (*W. Huh* and ***S. Jang*** are noted as providing the equal contribution)

In this paper, a new class of artificial synaptic architecture, a three-terminal device consisting of a vertically integrated monolithic tungsten oxide memristor, and a variable-barrier tungsten selenide/graphene Schottky diode are reported. I led the idea development, CMOS process, measurement of electrical characteristics and interpretation of results.

2. Ultrathin Conformable Organic Artificial Synapse for Wearable Intelligent Device applications

S. Jang, S. Jang, E.-H. Lee, M. Kang, G. Wang* and T.-W. Kim

ACS Appl. Mater. Interfaces **2019**, 11, 1071-1080 10 December IF: 7.21

Co-First Authorship (*S. Jang* and ***S. Jang*** are noted as providing the equal contribution)

We demonstrate the first ultrathin artificial synapse (~500 nm total thickness) that features freestanding ferroelectric organic neuromorphic transistors, which can stand alone without a substrate or an encapsulation layer. I led the measurement for artificial synapse characteristics and analyzed the mechanism of the device.

3. A self-rectifying TaO_y/nanoporous TaO_x memristor synaptic array for learning and energy-efficient neuromorphic systems

S. Choi, S. Jang, J. Moon, J. C. Kim, H. Y. Jeong, P. Jang, K.-J. Lee and G. Wang*

NPG Asia Materials **2018**, 10, 1097-1106 13 December 2018 IF: 8.15

Co-First Authorship (*S. Choi* and ***S. Jang*** are noted as providing the equal contribution)

We fabricated a self-rectifying memristor for an artificial synapse employing a Pt/TaO_y/NP TaO_x/Ta stack on a SiO2/Si substrate that can effectively suppress the undesired neural signal in ANNs and mimic essential synaptic functions. A potential switching mechanism is suggested and discussed based on the shift in the Ohmic-like contact site driven by the change in the Oxygen vacancy distribution in the NP TaO_x layer under an electric field and the intrinsic Schottky contact at the Pt/TaO_y interface. I initiated the idea of the paper and led the overall process of fabrication, and measurement of electrical characteristics of the device.

4. One-One-dimensional organic artificial multi-synapses enabling electronic-textile neural network for wearable neuromorphic applications

S.Ham, M. Kang, S.Jang, J.Jang, S.Choi, T.-W. Kim*, and G. Wang*

Science Advances **2020**, 6: eaba1178 10 July 2020 IF: 14.14

we designed 1D fiber-shaped multi-synapses comprising ferroelectric organic transistors fabricated on a 100-μm Ag wire and used them as multisynaptic channels in an e-textile neural network for wearable neuromorphic applications. The device mimics diverse synaptic functions with excellent reliability even under 6000 repeated input stimuli and mechanical bending stress. Various NOR-type textile arrays are formed simply by cross-pointing 1D synapses with Ag wires, where each output from individual synapse can be integrated and propagated without undesired leakage. Notably, the 1D multi-synapses achieved up to ~90 and ~70% recognition accuracy for MNIST and electrocardiogram patterns, respectively, even in a single-layer neural network, and

almost maintained regardless of the bending conditions.

5. Artificially Intelligent Tactile Ferroelectric Skin

K. Lee, S. Jang, K. L. Kim, M. Koo, C. Park, S. Lee, J. Lee, G. Wang*, and C. Park*

Adv. Sci. **2020**, 7, 2001662 03 September 2020 IF: 16.81

an integrated artificially intelligent tactile learning electronic skin (e-skin) based on arrays of ferroelectric-gate field-effect transistors with dome-shape tactile top-gates, which can simultaneously sense and learn from a variety of tactile information, is introduced. To test the e-skin, tactile pressure is applied to a dome-shaped top-gate that measures ferroelectric remnant polarization in a gate insulator. This results in analog conductance modulation that is dependent upon both the number and magnitude of input pressure-spikes, thus mimicking diverse tactile and essential synaptic functions. Specifically, the device exhibits excellent cycling stability between long-term potentiation and depression over the course of 10 000 continuous input pulses.

PUBLICATIONS (Co-Author)

1. Controllable switching filaments prepared via tunable and well-defined single truncated conical nanopore structures for fast and scalable SiOx memory

S. Kwon, **S. Jang**, J.-W. Choi, S. Choi, S. Jang, T.-W. Kim and G. Wang*

Nano Lett. **2017**, 17, 7462-7470 28 November 2017 IF: 12.71

2. Low temperature-grown KNbO3 thin films and their application to piezoelectric nanogenerators and self-powered ReRAM device

T.-H. Lee, H.-G. Hwang, **S. Jang**, G. Wang, S. Han, D.-H. Kim, C.-Y. Kang and S. Nahm*

ACS Appl. Mater. Interfaces **2017**, 9, 43220-43229 16 November 2017 IF: 7.50

3. Structurally engineered nanoporous Ta2O5-x selector-less memristor for high uniformity and low power consumption

S. Kwon, T.-W. Kim, **S. Jang**, J.-H. Lee, N. D. Kim, Y. Ji, C.-H. Lee, J. M. Tour* and G. Wang*

ACS Appl. Mater. Interfaces **2017**, 9, 34015-34023 9 September 2017 IF: 7.50

4. Energy-efficient three-terminal SiOx memristor crossbar array enabled by vertical Si/graphene heterojunction barristor

S. Choi†, J.-W. Choi†, J. C. Kim, H. Y. Jeong, J. Shin, **S. Jang**, S. Ham, N.-D. Kim, and G. Wang*

Nano Energy **2021**, 84, 105947 June 2021 IF: 16.60

5. Run-off election-based decision method for the training and inference process in an artificial

J. Jang, **S. Jang**, S. Choi, and G. Wang*

Scientific Reports **2021**, 13 January 2021 IF: 4.38

6. Retina-inspired structurally tunable synaptic perovskite nanocones

K. Lee, H. Han, Y. Kim, J. Park, S. Jang, H. Lee, S. W. Lee, H. Y. Kim, Y. Kim, T. Kim, D. Kim, G. Wang, C. Park*

Adv. Func. Mater. **2021**, 2105596 07 August 2021 IF: 19.92

7. Bird-inspired self-navigating artificial synaptic compass

Y. Kim, K. Lee, J. Lee, S. Jang, H. Y. Kim, H. Lee, S. W. Lee, G, Wang, C. Park*

ACS Nano, **2021**, 20116-20126 18 November 2021 IF: 15.88

8. A learning-rate modulable and reliable TiOx memristor array for robust, fast, and accurate neuromorphic computing

J. Jang†, S. Gi†, I. Yeo, S. Choi, **S. Jang**, S. Ham, B. Lee* and G. Wang*

Adv. Sci., 2022, 2201117 05 June 2022 IF: 17.52

PATENTS

1. **Title:** *Nanoporous Oxide-based Artificial Synapse Device and Method of Manufacturing the Same*

Gunuk Wang, Sanghyeon Choi, and Seonghoon Jang

: Main-inventor 10 September 2018

Patent application number: 10-2018-0107922

This patent is about the neuromorphic device, called as artificial synapse, which imitates the principles of biological synapses in a huge network of neurons, and method of manufacturing the device.

2. **Title:** *3-Terminal diagonal memtransistor system, apparatus and method for convolution network processing using the same*

Gunuk Wang, Jingon Jang, Seonggil Ham, and Seonghoon Jang

GRANTS, AWARDS, SCHOLARSHIP, AND FELLOWSHIPS

Best Poster Presentation Award	**ICME&D** 2021
KU Graduate Student Achievement Award	**Korea Univ.** 2021
Best Research Presentation Award	**KCS** 2021
KU-KIST graduate School 2020 Excellent Thesis Award	**KU-KIST** 2020
Samsung Electronics Industry-University Scholarship	**Samsung Electronics** 2020
Global Ph.D. Fellowship.	**NRF** 2019
Korea University-Samsung Electronics 2019 Academic Cooperation Excellence Award	**Samsung Electronics** 2019
Best Oral Presentation Award	**MRS-K** 2019
Convergence symposium best post award	**Korea University** 2017
Best Poster Presentation Award (Fall)	**KPS** 2017
Best Oral Presentation Award (Spring)	**KPS** 2017