



## wilman tsai

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### Publications

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#### PUBLICATIONS

- **High-Density STT-Assisted SOT-MRAM (SAS-MRAM) for Energy-Efficient AI Applications** *IEEE TRANSACTIONS ON MAGNETICS*  
Xue, F., Hwang, W., Tsai, W., Wang, S.  
2025; 61 (4)
- **Efficient Memory Integration: MRAM-SRAM Hybrid Accelerator for Sparse On-Device Learning** *Design Automation Conference*  
Zhang, F., Wang, S., Tsai, W., Fan, D., Hwang, W., Xue, F.  
2024
- **Atomic Layer Deposition of WO<sub>3</sub>-doped In<sub>2</sub>O<sub>3</sub> for Reliable and Scalable BEOL-Compatible Transistors** *Nature Communications*  
Yoo, C., Tsai, W., Meng, ., McIntyre, P., Hartano, J., Saini, B.  
2024
- **On-Device Continual Learning with STT-Assisted-SOT MRAM based In-Memory Computing** *IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS*  
Zhang, F., Tsai, W., Wang, S., Fan, D., Hwang, W., Xue, F.  
2024
- **Dimensional Scaling of Ferroelectric Properties of Hafnia-Zirconia Thin Films: Electrode Interface Effects** *ACS Nano*  
Huang, F., Saini, B., Tsai, W., Wong, P., McIntyre, P., Wong, S.  
2024
- **Atomic Layer Deposition of WO<sub>3</sub>-doped In<sub>2</sub>O<sub>3</sub> for Reliable and Scalable BEOL-Compatible Transistors** *Nature Communications*  
Yoo, C., Hartanto, J., Tsai, W., McIntyre, P.  
2024
- **Thermal optimization of two-terminal SOT-MRAM** *Journal of Applied Physics*  
Su, H., Tsai, W., Wang, S., Pop, E.  
2024; 135
- **Experimental Demonstration of Field-Free STT-Assisted SOT-MRAM (SAS-MRAM) with Four Bits per SOT Programming Line** *VLSI Symposium*  
Hwang, W., Xue, F., Tsai, W., Bao, X., Wang, S.  
2024
- **Cryogenic investigation of polarization switching in ultra-thin HZO ferroelectric capacitors** *2023 Materials Research Society Fall Meeting*  
Saini, B., Tsai, W., McIntyre, P.  
2023
- **Mechanism of polarization "Wake-Up" in ferroelectric Hafnia-Zirconia thin films** *Solid State Electronics*  
Saini, B., Choi, Y., Huang, F., Tsai, W., McIntyre, P.  
2023

- **2-terminal SOT-MRAM at Deeply Scaled Technology Nodes with 1x nm MTJ Critical Dimension** *Stanford NMTRI*  
Hwang, W., Tsai, W., Wang, S.  
2023
- **Field-free spin-orbit torque switching assisted by in-plane unconventional spin torque in ultrathin [Pt/Co]N** *Nature Comm.*  
Xue, F., Bao, X., Tsai, W., Wang, S.  
2023
- **Energy-Efficient Computing With High-Density, Field-Free STT-Assisted SOT-MRAM** *IEEE TRANSACTIONS ON MAGNETICS*  
Hwang, W., Tsai, W., Bao, X., Wang, S.  
2023
- **Continual Learning with STT-Assisted-SOT MRAM based In-Memory Computing** *Design Automation Conference*  
Zhang, F., Tsai, W., Wang, S., Fan, D.  
2023
- **Atomic Layer Deposition of WOX-doped In2O3 for High-Performance BEOL-Compatible Transistors** *Materials Research Society, Fall 2023*  
Yoo, C., Tsai, W., Baniecki, J., McIntyre, P.  
2023
- **First Observation of Ultra-high Polarization (~108  $\mu\text{C}/\text{cm}^2$ ) in Nanometer Scaled High Performance Ferroelectric HZO Capacitors with Mo Electrodes** *VLSI Symposium*  
Huang, F., Tsai, W., Wong, P., McIntyre, P.  
2023
- **Enhanced spin-orbit torque by interfacial spin-orbit precession in Mg-capped Pt/Co in-plane system detected by spin-wave coupling** *Nature Materials*  
Xue, F., Tsai, W., Hwang, W., Wang, S.  
2023
- **Field-Induced Ferroelectric Phase Evolution During Polarization “Wake-Up” in Hf0.5Zr0.5O2 Thin Film Capacitors** *Advanced Electronic Materials*  
Saini, B., Baniecki, J., Tsai, W., McIntyre, P.  
2023
- **Enhanced Switching Reliability of Hf0.5Zr0.5O2 Ferroelectric Films 2 Induced by Interface Engineering** *ACS Appl. Mater. Interfaces*  
Huang, F., Tsai, W., McIntyre, P., Wong, S.  
2023
- **Cryogenic investigation of polarization switching in ultra-thin HZO ferroelectric capacitors** *Stanford Non-volatile Memory Technology Research Initiative 2023*  
Saini, B., Tsai, W., McIntyre, P.  
2023
- **Atomic Layer Deposition of WO3 doped In2O3 for High Performance BEOL Compatible Transistors** *54th IEEE Semiconductor Interface Specialists Conference*  
Yoo, C., Tsai, W., McIntyre, P.  
2023
- **Unconventional materials and fabrications for high- density SOT-MRAM with multi-bit MTJs on shared SOT line** *Stanford NMTRI*  
Xue, F., Tsai, W., Wang, S.  
2023
- **Observation of anti-damping spin-orbit torques generated by in-plane and out-of-plane spin polarizations in MnPd3** *Nature Materials*  
DC, M., Hou, V., Xue, F., Lin, S., Tsai, W., Tsymbal, E., Wang, W., Wang, S. X.  
2023
- **The Field-dependence Endurance Model and Its Mutual Effect in Hf-based Ferroelectrics** *International Reliability Conference*  
Chang, Y., Tsai, W., McIntyre, P., Liao, P., Yu, Z., Lin, Y.  
2022

- **New Ferroelectrics for Neuromorphic and Storage Class Memory**  
Saini, B., Tsai, W., McIntyre, P.  
SRC nCORE IMPACT Center.  
2022
- **Performance benchmarking of spin-orbit transfer magnetic RAM (SOT-MRAM) for deep neural network (DNN) accelerators** *International Memory Workshop*  
Luo, Y., Yu, S., Wang, S., Tsai, W.  
2022
- **CeO<sub>2</sub> Doping of Hf<sub>0.5</sub>Zr<sub>0.5</sub>O<sub>2</sub> Thin Films for High Endurance Ferroelectric Memories** *Adv. Electron. Mater.*  
Yu, Z., Wong, P., Tsai, W., McIntyre, P., Baniecki, J., Chang, C., Mehta, A.  
2022; 2101258 (1)
- **Phase Evolution with Wake-Up Effect in HZO Thin Film Capacitors using Synchrotron X-ray Diffraction** *Semiconductor Interface Specialists Conference*  
Saini, B., Choi, Y., Tsai, W., McIntyre, P.  
2022
- **Nanocrystallite Seeding of Metastable Ferroelectric Phase Formation in Atomic Layer-Deposited Hafnia–Zirconia Alloys** *ACS Applied Materials & Interfaces*  
Yu, Z., Saini, B., Wong, P., Tsai, W., McIntyre, P., Huang, F., Baniecki, J., Mehta, A.  
2022
- **Energy Efficient Computing with High Density, Field Free STT Assisted SOT MRAM** *Magnetic Recording Conference (TMRC) 2022*  
Hwang, W., Bao, X., Tsai, W., Wang, S.  
2022
- **Wake-up Free, BEOL Compatible, Low Operation Voltage (1.2 V), and High Endurance HZO FeRAM Scaled to 40 nm × 40 nm Size with Mo Electrodes** *IEDM*  
Huang, F., Tsai, W., Wong, H., McIntyre, P., Wong, S.  
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- **Energy Efficient Computing with High Density, Field Free STT Assisted SOT MRAM (SAS)** *TMRC*  
Hwang, W., Bao, X., Tsai, W., Wang, S.  
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- **Experimental Demonstration of BEOL-Compatible, Field-Free STT-Assisted SOT-MRAM (SAS-MRAM) with One or Multiple Bits per SOT Programming Line** *IEDM 2022*  
Hwang, W., Bao, X., Tsai, W., Wang, S.  
2022
- **Low Temperature (350 °C) Annealing for Ferroelectric Hf<sub>0.5</sub>Zr<sub>0.5</sub>O<sub>2</sub> Thin Films** *Materials Research Society 2021. Late news*  
Yu, Y., Tsai, W., McIntyre, P.  
2021
- **High-Performance BEOL-Compatible Atomic-Layer-Deposited In<sub>2</sub>O<sub>3</sub> Fe-FETs Enabled by Channel Length Scaling down to 7 nm: Achieving Performance Enhancement with Large Memory Window of 2.2 V, Long Retention > 10 years and High Endurance > 1e8 Cycles** *IEDM*  
Lin, Z., Tsai, W., McIntyre, P., Ye, P.  
2021
- **Towards a High-Density SOT-MRAM for On-Chip Embedded Memory Applications** *NMTRI, Stanford*  
Hwang, W., Tsai, W., Wang, S.  
2021
- **CeO<sub>2</sub>-Doped Hf<sub>0.5</sub>Zr<sub>0.5</sub>O<sub>2</sub> Ferroelectrics for High Endurance Embedded Memory Applications** *IEDM*  
Yu, Y., Wong, P., Tsai, W., McIntyre, P.  
2021
- **Spin-orbit torques of an in-plane magnetized system modulated by the spin transport in the ferromagnetic Co layer** *Applied Physics Letters*  
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- **Tunable Spin-Orbit Torque Efficiency in In-plane and Perpendicular Magnetized [Pt/Co]n Multilayer** *Applied Physics Letters*  
Xue, F., Tsai, W., Wang, S.  
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- **Observation of anti-damping spin-orbit torques generated by in-plane and out-of-plane spin polarizations in antiferromagnetic MnPd3** *Nature Materials*  
DC, M., Tsai, W., Wang, S.  
2021
- **Materials Requirements of High-Speed and Low-Power Spin-Orbit-Torque Magnetic Random-Access Memory** *Journal of the Electron Devices Society*  
Li, X., Wang, S., Tsai, W., Lin, S.  
2020
- **Memory Technologies for Emerging Computing Applications** *Strategic Materials Conference*  
Tsai, W., McIntyre, P., Wang, S., Kummel, A., Datta, S.  
2020
- **Large and Robust Charge-to-Spin Conversion in Sputtered Weyl Semimetal WTex with Structural Disorder** *Nature Materials*  
Li, X., Xue, F., Lin, S., Tsai, W., Suzuki, Y., Wang, S.  
2020
- **Emerging Memory Devices, 2019 IRDS Roadmap, Beyond CMOS**  
Li, X., Lin, S., Tsai, W.  
2020
- **Accelerating Deep Neural Networks in Processing-in-Memory Platforms: Analog or Digital Approach?** *IEEE Computer Society Annual Symposium on VLSI*  
Fan, D., Lin, S., Tsai, W.  
2019
- **Performance Benchmarking of p-type In<sub>0.65</sub>Ga<sub>0.35</sub>As/GaAs<sub>0.4</sub>Sb<sub>0.6</sub> and Ge/Ge<sub>0.93</sub>Sn<sub>0.07</sub> Hetero-junction Tunnel FETs** *IEDM*  
Pandey, R., Datta, S., Tsai, W.  
2016
- **Record high current density and low contact resistance in MoS<sub>2</sub> FETs by ion doping** *VLSI-TSA Symposium*  
Fathipour, S., Seabaugh, A., Yeh, L., Tsai, W.  
2016
- **Demonstration of Black Phosphorous P-MOSFETs with h-BN/Al<sub>2</sub>O<sub>3</sub> Bilayer Gate Dielectric: Achieving Ion = 850μA/μm, gm = 340μS/μm, EOT = 2nm and Rc = 0.58kΩ•μm** *IEDM*  
Yang, L., Ye, P., Yeh, L., Tsai, W.  
2016
- **CHALLENGES AND PROGRESS IN III-V MOSFETs FOR CMOS CIRCUITS** *International Journal of High Speed Electronics and Systems*  
Tsai, W., Lee, J., OKTYABRSKY, S., KOVESHNIKOV, S.  
2008
- **Performance comparison of sub 1 nm sputtered TiN/HfO<sub>2</sub> nMOS and pMOSFETs** *IEDM*  
Tsai, W., Ragnarsson, L., Heyns, M.  
2003
- **Variation of composition of sputtered TiN films as a function of target nitridation, thermal anneal, and substrate topography** *Appl. Phys. Lett.*  
Tsai, W., Delfino, M.  
1995; 67 (220)