Manasa Kaniselvan

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PROFILE

Working at the intersection of Semiconductor Physics and High Performance Computing to develop atomistic simulations for resistive memory cells. Collaborating with experimental teams to understand the operation of fabricated devices through theory-experiment co-design. Interested in incorporating Machine Learned (ML) workflows to enable atomistic treatments of other emerging memory devices at experimentally-relevant system sizes and timescales.

EDUCATION

ETH Zurich Zurich, Switzerland
Candidate for PhD, Information Technology and Electrical Engineering November 2021–present

University of Waterloo Waterloo, ON, Canada
Master of Applied Science (MASc), Electrical and Computer Engineering September 2019–May 2021

University of Waterloo Waterloo, ON, Canada
Bachelor of Applied Science (BASc), Nanotechnology Engineering. September 2014–May 2019

EXPERIENCE

Scientific Assistant & PhD Candidate - ETH Zürich Zürich, Switzerland
Advisor: Dr. Mathieu Luisier, Professor September 1st 2021 - 2026

- Developing multi-scale atomistic models for resistive switching devices, using Density Functional Theory (DFT), *ab initio* quantum transport, and Kinetic Monte Carlo. Accelerating the developed codes on GPUs and multicore architectures. Working with experimental collaborators at IBM Zurich to realize devices and investigate their operating mechanisms.

PhD Intern - Samsung Semiconductor Inc San Jose, CA, USA
Supervisor: Dr. Byounghak Lee, Principle Engineer May 15th 2023 - August 4th 2023

- Developed and implemented a symmetry algorithm to accelerate semiconductor process/device simulations.

Research Assistant & MASc Student - University of Waterloo Waterloo, ON, Canada
Advisor: Dr. Youngki Yoon, Associate Professor September 1st 2019 - September 1st 2021

- Used Density Functional Theory and quantum transport codes to design and simulate transistor devices made from 2D materials. Collaborated with experimental partners at Sungkyunkwan University, South Korea, to fabricate devices.

Undergraduate Intern - Waterloo Institute for Nanotechnology Waterloo, ON, Canada
Supervisor: Dr. Dayan Ban, Professor January 1st 2018 - September 1st 2018

- Wrote a MATLAB code to simulate the operation of Resonant-Phonon Quantum Cascade Lasers (QCLs), based on self-consistently solved wavefunctions and charge distributions. Implemented global optimization methods to search for designs with higher-temperature lasing potential. Assisted in electro-optical characterization of fabricated devices.

Undergraduate Intern - Adaptive Surface Technologies Cambridge, MA, USA
Supervisor: Dr. Tehila Nahum, Principle Engineer September 1st 2016 - April 30th 2017

- AST develops slippery coatings by infusing nano-porous surfaces with lubricants. Worked in a team of three engineers to formulate a food-safe slippery container coatings for one of the largest companies in the consumer packaging industry.

Undergraduate Intern - National Institute of Materials Science Tsukuba, Ibaraki, Japan
Supervisor: Dr. Genki Yoshikawa, Associate Professor January 1st 2016 - April 1st 2016

- Optimized the coating of drop-casted polymer films on a membrane-based olfactory nanosensor. Designed and 3D printed parts to customize dispensing equipment. Used COMSOL multiphysics to model sensor performance.

Teaching & Supervision

Lectures

- **(Guest lecturer) Brain Inspired Computing: From Devices to Applications, ETH Zurich** April 2024
  Designed a lecture on device modelling approaches for non-volatile resistive memory.
- **(Co-Lecturer) Digital Electronics, Ashesi University (in collaboration with ETH Zurich)** February 2024
  Primary lecturer for a 2-week block-course on Digital Electronics held as part of the ETH-Ashesi collaborative Masters program in Ghana. Also served as a technical interviewer for applicants of the following cohort.

Student Project Supervisions

At ETH, Master students can work with PhD students who propose and lead a semester/thesis project.

- **Masters' thesis of Alexander Maeder, ETH Zurich** September 2023 - March 2024
  Distributing a GPU-accelerated Kinetic Monte Carlo code for nanoionic memory device simulations. Co-supervised with Dr. Alexandros Ziogas and Vincent Maillou. (***Awarded the ETH Medal***)
- **Masters' thesis of Jente Clarysse, ETH Zurich** April 2023 - October 2023
  Developing simulations of thermally-activated switching in resistive memory. (***Awarded the ETH Medal***)
- **Masters' semester project of Jente Clarysse, ETH Zurich** September 2022 - January 2023
  Developing a graph-based model of current flow through atomistic structures.
- **Masters' semester project of Zhouyang Yu, ETH Zurich** September 2022 - January 2023
  Preforming quantum transport simulations on Interband Cascade Lasers (ICLs). Co-supervised with Prof. Matheiu Luisier.
- **Bachelor thesis of Patrik Gjini, ETH Zurich** February 2022 - May 2022
  Implemented a Fast Multipole Method algorithm for Poisson's equation. Co-supervised with Dr. Marko Mladenovic.
- **Masters' semester project of Patrick Bütler, ETH Zurich** February 2022 - May 2022
  Investigating resistive switching in $MoTe_2$ with *ab-initio* Molecular Dynamics. Co-supervised with Jonathan Backmann.
- **Research projects of Patrick Kim and Raymond Chong, Deep River Science Academy** May 2015 - Aug 2015
  Minimizing the interfacial roughness of sputtered metal alloy thin films to investigate nano-scale corrosion mechanisms, using X-Ray Reflectometry and X-Ray Diffraction. Counted towards the students' high-school course credit.

Teaching Assistant (TA) Positions

- **Quantum Transport in Nanostructures, ETH Zurich** February 2022-2024 - May 2022-2024
  Supervised one third of the tutorials for the course held in 2022, 2023, and 2024.
- **Linear Circuits (NE140), University of Waterloo** January 2021 - April 2021
  Prepared and taught all tutorials for the course held in 2020 and 2021. Won a TA excellence award.
- **Nanoelectronics (NE471), University of Waterloo** September 2020 - December 2020
  Held office hours for student questions, prepared assignments, and marked exams.
- **Electronic Circuits (NE344), University of Waterloo** May 2020 - August 2020
  Prepared and taught all remote (synchronous) tutorials.

Other Activities

Team Lead - UW Nano Robotics Group (UWNRG) Waterloo, ON, Canada
January 2015 - July 2019

- UWNRG designs micro-robotic actuation systems to compete at the annual IEEE International Conference for Robotics and Automation (ICRA) Microbotics Challenges. We were the only undergraduate team competing.
- Was the Technical Lead for the development of a microbot we named SAM (Solenoid Actuated Microbot).
- Acquired funding for lab expenses, equipment, cleanroom usage, and conference travel costs. Competition Record: 3rd place (ICRA 2015, Seattle USA), 1st place (ICRA 2016, Stockholm Sweden), 2nd place (ICRA 2018, Brisbane Australia).

Awarded Funding

- "Flexible Photovoltaics with 2D Material Heterostructures" (NSERC PGSD-3 Doctoral Award) - 63,000 CAD   2021
- "Simulations of semiconductor quantum structures" (NSERC Undergraduate Student Research Award) - 4,000 CAD 2018
- "Modeling of quantum cascade lasers" (NSERC Undergraduate Student Research Award) - 4,000 CAD   2017

Selected Scholarships & Awards

- Top 10% (out of 715) Poster award at the Psi-K Conference   2022
- Sanford Fleming Foundation (SFF) Teaching Assistant Excellence Award   2021
- Waterloo Dean's Entrance Award (Graduate)   2019
- NIMS (Japan) Internship Fellowship   2016
- Waterloo President's Scholarship (Undergraduate)   2014

Journal & Conference Papers

'*' = equal contribution, '+' = supervised masters' students

Selected:

1. **M. Kaniselvan***, A. Maeder*+, M. Mladenovic, M. Luisier, A. Ziogas, "Accelerated Kinetic Monte Carlo Simulations of Atomistically-Resolved Resistive Memory Arrays". *International Conference for High Performance Computing, Networking, Storage, and Analysis ('SC24). (*Acceptance rate: 22.7%)*

2. **M. Kaniselvan**, M. Mladenović, J. Clarysse+, K. Portner, and M. Luisier, "Insights behind multi-level conductance transitions in HfO_x memristors". *Device Research Conference (DRC)*, June 2024. *(*Acceptance rate, contributed talks: 28%)*

3. **M. Kaniselvan**, M. Luisier, and M. Mladenovic, "Atomistic Modelling of Field-Induced Resistive Switching in Valence Change Memory," *ACS Nano*, April 2023. doi: 10.1021/acsnano.2c12575 *(*Journal Cover Article)*

   In the media: [Covered by ETH] [Covered by the Werner Siemens Foundation]

4. H. Park*, A. Sen*, **M. Kaniselvan**, A.AlMutairi, A. Bal, L. Lee, Y.Yoon, and S. Kim, "Wafer-scale Nanoporous 2D Active Pixel Image Sensor Matrix with Highly Uniformity, High Sensitivity, and Rapid Switching," *Advanced Materials*, February 2023. doi: 10.1002/adma.202210715 *(*Journal Cover Article)*

5. **M. Kaniselvan**, M. Sritharan, and Y. Yoon, "Mitigating Tunneling Leakage in Ultrascaled HfS_2 pMOS Devices with Uniaxial Strain," *IEEE Electron Device Letters*, June 2022 doi:10.1109/LED.2022.3179228 *(*Editor's Pick)*

Other:

6. Alexander Maeder+, **Manasa Kaniselvan**, Marko Mladenovic, Mathieu Luisier and Alexandros Nikolaos Ziogas, "A Distributed Conjugate Gradient Solver for Kinetic Monte Carlo simulations under applied fields." *Platform for Advanced Scientific Computing (PASC24)*, Zurich, Switzerland, June 2024. Poster and ACM Student Research Conference submission.

7. C. Weilenmann, A. Ziogas, T. Zellweger, K. Portner, M. Mladenović, **M. Kaniselvan**, T. Moraitis, M. Luisier, A. Emboras, "Single Neuromorphic Memristor closely Emulates Multiple Synaptic Mechanisms for Energy Efficient Neural Networks". Accepted paper at *Nature Communications*. Arxiv link: https://arxiv.org/abs/2402.16628

8. M. Sritharan, R.K.A Bennett, **M. Kaniselvan**, and Y. Yoon, "A Comparative Study on 2D Materials with Native High-Oxides for Ultrascaled Transistors", *Materials Today Electronics*, March 2024. doi:10.1016/j.mtelec.2024.100096

9. Marko Mladenovic, **Manasa Kaniselvan**, Christoph Weilenmann, Alexandros Emboras, and Mathieu Luisier *Termination-Dependence of Resistive Switching in $SrTiO_3$-based Valence Change Memory.* International Workshop on Computational Nanotechnology (IWCN), Barcelona, Spain, June 2023. Contributed talk.

10. **M. Kaniselvan**, M. Luisier, and M. Mladenovic, "An Atomistic Modelling Framework for Valence Change Memory Cells," *Solid State Electronics: LETTERS from the International Conference on Simulation of Semiconductor Processes and Devices (SISPAD)*, October 2022 doi: 10.10632F5.0053789.

11. **M. Kaniselvan** and Y. Yoon, "Strain-tuning $PtSe_2$ for high ON-current lateral tunnel field-effect transistors," *Applied Physics Letters*, vol. 119, no. 7, p. 073102, Aug. 2021. doi:10.1063%2F5.0053789

12. G. Han, **M. Kaniselvan**, and Y. Yoon, "Photoresponse of MoSe$_2$ Transistors: A Fully Numerical Quantum Transport Simulation Study," *ACS Applied Electronic Materials*, vol. 2, no. 11, pp. 3765–3772, Nov. 2020. doi:10.1021/acsaelm.0c00795

13. M. Naqi*, **M. Kaniselvan***, S. Choo*, G. Han, S. Kang, J. Kim, Y. Yoon, and S. Kim, "Ultrasensitive Multilayer MoS$_2$-Based Photodetector with Permanently Grounded Gate Effect," *Advanced Electronic Materials*, vol. 6, no. 4, p. 1901256, Feb. 2020. doi: 10.1002/aelm.201901256.

Submitted/In Revision:

14. **M. Kaniselvan**, M. Mladenović, C. Jente+, A. Maeder+, and M.Luisier, "Scaling limits of HfOx RRAM crossbar arrays". Submitted to the *IEEE International Electron Device Meeting*.

15. **M. Kaniselvan**, Y. Jeon, M. Mladenović, M.Luisier, and D. Akinwande, "Mechanisms of Resistive Switching in 2D Layered Materials". In review at *Nature Materials* since April 2024.

Peer Review Activity

Reviewer for: npj Computational Materials, IEEE Transactions on Electronic Devices, IEEE Electron Device Letters, Physical Review E, Physical Review Applied