

## PROFILE

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Working at the intersection of Semiconductor Physics, High Performance Computing and Machine Learning to design simulation codes for emerging resistive memory devices, which have applications in future on-chip memory and as neuromorphic computing primitives.

## EDUCATION

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### ETH Zurich

Candidate for PhD, Information Technology and Electrical Engineering

Zurich, Switzerland

November 2021–present

### University of Waterloo

Master of Applied Science (MSc), Electrical and Computer Engineering

Waterloo, ON, Canada

September 2019–May 2021

### University of Waterloo

Bachelor of Applied Science (BSc), Nanotechnology Engineering.

Waterloo, ON, Canada

September 2014–May 2019

## EXPERIENCE

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### Scientific Assistant (PhD Candidate) - ETH Zürich

Advisor: Dr. Mathieu Luisier, Professor

Zürich, Switzerland

September 1<sup>st</sup> 2021 - 2026

- Developing multi-scale atomistic models for resistive switching in emerging Non-Volatile Memories (NVM), using methods such as Density Functional Theory (DFT), *ab initio* quantum transport, Kinetic Monte Carlo, and Machine-learned interpolation methods. Accelerating the developed simulation codes on GPUs and multicore architectures. Working with experimental partners at ETH and IBM Zurich to realize new devices and investigate their operating mechanisms.

### PhD Intern in Device/Process Modelling - Samsung Semiconductor

Supervisor: Dr. Byounghak Lee, Principle Engineer

San Jose, CA, USA

May 15<sup>th</sup> 2023 - August 4<sup>th</sup> 2023

- Developed and implemented a symmetry-aware topological classification algorithm for large-scale semiconductor device and process simulations. Presented the results to partners in Samsung Korea.

### Research Assistant (MSc Student) - University of Waterloo

Advisor: Dr. Youngki Yoon, Associate Professor

Waterloo, ON, Canada

September 1<sup>st</sup> 2019 - September 1<sup>st</sup> 2021

- Used Density Functional Theory and Non-Equilibrium Green's Function-based transport codes to design and simulate devices made from 2D materials. Investigated defect and strain-engineering in FET and TFET structures. Collaborated with experimental partners at Sungkyunkwan University, South Korea, to fabricate and test devices.

### Internship - Waterloo Institute for Nanotechnology (WIN)

Supervisor: Dr. Dayan Ban, Professor

Waterloo, ON, Canada

January 1<sup>st</sup> 2018 - September 1<sup>st</sup> 2018

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

### Formulations Engineering Intern - Adaptive Surface Technologies (AST)

Supervisor: Dr. Tehila Nahum, Principle Formulations Engineer

Cambridge, MA, USA

September 1<sup>st</sup> 2016 - April 30<sup>th</sup> 2017

- AST develops slippery coatings on the principle of infusing a nanoporous surface with a lubricant. Worked in a team of three engineers to formulate food-safe container coatings for a customer in the consumer packaging industry.

### Internship - National Institute of Materials Science (NIMS)

Supervisor: Dr. Genki Yoshikawa, Associate Professor and Group Leader

Tsukuba, Ibaraki, Japan

January 1<sup>st</sup> 2016 - April 1<sup>st</sup> 2016

- Optimized the coating of drop-casted polymer films on a membrane-type sensor which measures mechanical deflection upon gas absorption to perform ‘olfactory’ sensing. Designed and 3D printed parts to customize dispensing equipment. Used COMSOL multiphysics to model sensor performance.

### Internship - Canadian Nuclear Laboratories (CNL)

Chalk River, Ontario, Canada

Supervisor: Dr. Syed Bukhari, Research Associate, Neutron Scattering Branch

May 2015 - August 2015

- Optimized sputtering parameters to minimize the interfacial roughness between stacked metal-alloy thin films and study their nanoscale corrosion mechanisms.

## TEACHING & SUPERVISION

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### Lectures

- **(Guest lecture) Brain Inspired Computing: From Devices to Applications, ETH Zurich** April 2024  
Designed and delivered a lecture and tutorial session on device modelling approaches for non-volatile resistive memory.
- **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 candidates who independently 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 for his master thesis)**
- **Masters’ thesis of Jente Clarysse, ETH Zurich** April 2023 - October 2023  
Simulating thermally-activated switching in resistive memory. **(Awarded the ETH Medal for her master thesis)**
- **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  
Performing quantum transport simulations on Interband Cascade Lasers (ICLs) using an in-house NEGF solver. Co-supervised with Prof. Matheiu Luisier.
- **Bachelor thesis of Patrik Gjini, ETH Zurich** February 2022 - May 2022  
Implemented a Fast Multipole Method algorithm to accelerate the solution of Poisson’s equation on unstructured grids, written in Python. Co-supervised with Dr. Marko Mladenovic.
- **Masters’ semester project of Patrick Bütler, ETH Zurich** February 2022 - May 2022  
Investigating phase transition-induced resistive switching in monolayer MoTe<sub>2</sub> towards non-volatile memory applications, using *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 Positions

- **Quantum Transport in Nanostructures, ETH Zurich** February 2022-2024 - May 2022-2024  
Taught 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 remote (synchronous) tutorials.
- **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.
- **Linear Circuits (NE140), University of Waterloo** January 2020 - April 2020  
Prepared and taught all tutorials.

## OTHER ACTIVITIES

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### Team Lead - UW Nano Robotics Group (UWNRG)

Waterloo, ON, Canada  
January 2015 - July 2019

- UWNRG designs microbotic actuation systems to compete at the annual IEEE ICRA Microbotics Challenges.
- Led the development of a microbot called SAM (Solenoid Actuated Microbot). Managed funding applications for lab expenses, equipment, cleanroom usage, and conference travel costs.
- Competition Record: 3rd place (at ICRA 2015), 1st place (at ICRA 2016), 2nd place (at ICRA 2018).

## PROJECT FUNDING

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- “Flexible Photovoltaics with 2D Material Heterostructures” (NSERC PGSD 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

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- Top 10% (out of 715) Poster award at the Psi-K Conference 2022
- Waterloo Faculty of Engineering Awards (x2) 2020
- Sanford Fleming Foundation (SFF) Teaching Assistant Excellence Award 2021
- Waterloo Dean’s Entrance Award (Graduate) 2019
- NIMS (Japan) Internship Program Fellowship 2016
- Waterloo President’s Scholarship (Undergraduate) 2014

## JOURNAL & CONFERENCE PAPERS

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‘\*’ = equal contribution, ‘+’ = supervised master student projects

### Selected:

1. **M. Kaniselvan**, M. Mladenović, C. Jente, and M. Luisier, “Scaling limits of HfOx Resistive Memory”. In preparation.
2. **M. Kaniselvan**, Y. Jeon, M. Mladenović, M. Luisier, and D. Akinwande, “Mechanisms of Resistive Switching in 2D Layered Materials”. In review since April 2024.
3. **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 and Analysis (’SC24)*. (**\*Acceptance rate: 22.7%**)
4. **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]
5. 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**)
6. **M. Kaniselvan**, M. Sritharan, and Y. Yoon, “Mitigating Tunneling Leakage in Ultrascaled HfS<sub>2</sub> pMOS Devices with Uniaxial Strain,” *IEEE Electron Device Letters*, June 2022 doi:10.1109/LED.2022.3179228 (**\*Editor’s Pick**)

## Other:

7. Alexander Maeder+, **Manasa Kaniselvan**, Marko Mladenovic, Mathieu Luisier and Alexandros Nikoloas 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.
8. **M. Kaniselvan**, M. Mladenović, J. Clarysse+, and M. Luisier, “Insights behind multi-level conductance transitions in  $\text{HfO}_x$  memristors”. *Device Research Conference (DRC)*, June 2024.
9. 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”. Under revision at *Nature Communications*. Arxiv link: <https://arxiv.org/abs/2402.16628>
10. 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
11. Marko Mladenovic, **Manasa Kaniselvan**, Christoph Weilenmann, Alexandros Emboras, and Mathieu Luisier *Termination-Dependence of Resistive Switching in  $\text{SrTiO}_3$ -based Valence Change Memory*. International Workshop on Computational Nanotechnology (IWCN), Barcelona, Spain, June 2023. Contributed talk.
12. **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: 10.1063/2F5.0053789. Contributed talk.
13. **M. Kaniselvan** and Y. Yoon, “Strain-tuning  $\text{PtSe}_2$  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
14. G. Han, **M. Kaniselvan**, and Y. Yoon, “Photoresponse of  $\text{MoSe}_2$  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
15. M. Naqi\*, **M. Kaniselvan\***, S. Choo\*, G. Han, S. Kang, J. Kim, Y. Yoon, and S. Kim, “Ultrasensitive Multilayer  $\text{MoS}_2$ -Based Photodetector with Permanently Grounded Gate Effect,” *Advanced Electronic Materials*, vol. 6, no. 4, p. 1901256, Feb. 2020. doi: 10.1002/aelm.201901256.

## NON-REFEREED CONFERENCE CONTRIBUTIONS

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1. **Manasa Kaniselvan**, Marko Mladenovic, Patrik Gjini+, and Mathieu Luisier *Modelling transport in valence change memory cells*. Psi-k Conference, Lausanne, Switzerland, August 2022. Poster.
2. **Manasa Kaniselvan**, Marko Mladenovic, Patrik Gjini, and Mathieu Luisier *Modelling transport in valence change memory cells*. CECAM Workshop on “Quantum transport methods and algorithms: from particles to waves approaches”, ETH Zürich, Switzerland, July 2022. Poster.
3. **Manasa Kaniselvan**. *Engineering the Performance of 2D Transition Metal Dichalcogenide Nanotransistors through Quantum Transport Simulations*. Nanotechnology Seminar delivered at the University of Waterloo, June 2021.
4. Boyu Wen, Chao Xu, Siyi Wang, Sm Shazzad Rassel, **Manasa Kaniselvan**, Chris Deimert, Zbigniew Wasilewski and Dayan Ban *Novel 4-well THz QCL with hybrid injection/extraction channels*. ITQW2019: Infrared Terahertz Quantum Workshop.
5. Mary Chen\*, **Manasa Kaniselvan\***, Corin Seeleman\*, Danielle Smith\*. *A Real-Time Non-Invasive Sensor for Monitoring Laser-Induced Temperature in Medical Applications*. Waterloo Engineering Design Symposium 2019. Waterloo, ON, Canada. Oral presentation & poster.
6. **UW Nano Robotics Group**. *Solenoid Actuated Microbot (SAM)*. 2018 IEEE IEEE International Conference on Robotics and Automation (ICRA). Brisbane, Australia. Competition & poster.
7. **UW Nano Robotics Group**. *ElectroMagnetic Micro Actuation (EMMA): Version 2*. 2016 IEEE International Conference on Robotics and Automation (ICRA). Stockholm, Sweden. Competition & poster
8. **UW Nano Robotics Group**. *ElectroMagnetic Micro Actuation (EMMA)* 2015 IEEE International Conference on Robotics and Automation (ICRA). Seattle, Washington, USA. Competition & poster

## PEER REVIEW ACTIVITY

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