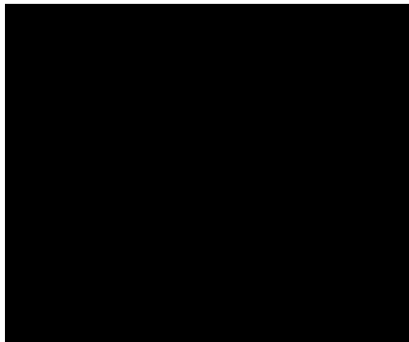## Alberto Gullino

Research topics

○ Optoelectronic devices

○ VCSELs

○ III-V alloys

○ Physics-based simulations

○ Drift-diffusion model

○ Tunnel junctions

○ NEGF

○ TCAD

Professional Experience

1st Feb. 2023 – Now **Fellow researcher at CNR-IEIIT** (Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni del Consiglio Nazionale delle Ricerche), in Turin (Italy), within the research project "Design of high-power single mode VCSELs - Qyro–volens", in collaboration with TRUMPF Photonics, Inc., aimed at designing stable single-mode VCSELs for quantum-based gyroscopes.

1st Nov. 2019 – 31st Jan. 2023 **Ph.D. in Electronic Engineering** at DET (Politecnico di Torino) under the tutoring of Prof. Michele Goano, Giovanni Ghione, Francesco Bertazzi and Dr. Pierluigi Debernardi and Alberto Tibaldi in the "Microwave and Optoelectronics Group" (MOG). I've successfully defended my Ph.D. thesis entitled "Physics-based modeling of 850 nm Tunnel Junction VCSELs" on 21st September 2023. It treats the multiphysics and multiscale modelling of AlGaAs-based oxide-confined *pin* and novel TJ-VCSELs emitting at 850 nm. Experimental data on the investigated devices have been provided by Chalmers University of Technology [1,3] and Ulm University, Institute of Optoelectronics [4].

Dec. 2018 – 25th Oct. 2019 **M.Sc. thesis** at the Department of Electronics and Telecommunications (DET), at Politecnico di Torino. Begin of my work on the numerical modelling of tunnel junctions (TJ) inside Vertical-cavity surface-emitting lasers (VCSELs). Thesis title: "Carrier injection modelling in buried tunnel junction VCSELs".

During my four years of research on VCSELs modeling, I have worked to the development of an in-house physics-based 3D (2D cylindrical) solver (VENUS) and its reduced dimensionality version (D1ANA) [2], in a MATLAB environment. Both are based on a quantum-corrected drift-diffusion (QCDD) model to treat the carrier transport problem and QW optical response. The QCDD model is coupled with a non-equilibrium Green's function (NEGF) treatment of the TJ, that relies on quantum band-to-band tunneling [1,3,5]. The resulting NEGF-DD scheme is the electrical solver that is self-consistently coupled to an optical (VELM) and a thermal solver to fully characterize VCSELs operation in static [6,8-10] and small-signal [4] conditions.

Education: Summary

2019-2023. **Ph.D. in Electronics Engineering (XXXV Cycle)**
Thesis discussion: 21st Sept. 2023 (*cum laude*)
Politecnico di Torino – Italy

2017-2019. **M.Sc. degree in Nanotechnologies for ICTs**
Final grade: 110/110 *cum laude*
Politecnico di Torino – Italy

2014-2017. **B.Sc. degree in Physical Engineering**
Final grade: 97/110
Politecnico di Torino – Italy

2009-2014. **High school diploma**
Final grade: 95/110
Liceo Giolitti – Gandino
Bra (CN) – Italy

Language skills

Italian   Mother tongue
English   Professional -
          PET w. merit (B1)

Computer skills

MATLAB	●●●●
Sentaurus Synopsis	●○○○
Latex	●●●○
Git	●●○○
Microsoft Suite	●●●○
Windows	●●●○
Linux	●○○○
C, Python	●○○○
ROS	●○○○

Publications

[1] Tibaldi, A., Gonzalez Montoya, J. A., Alasio, M. G. C., Gullino, A., *et al.*, "Analysis of Carrier Transport in Tunnel-Junction Vertical-Cavity Surface-Emitting Lasers by a Coupled Nonequilibrium Green's Function–Drift-Diffusion Approach", *Phys. Rev. Applied* 14, 024037, **2020**. doi: 10.1103/PhysRevApplied.14.024037

[2] Gullino, A., Tibaldi, A., Bertazzi, F., Goano, M., Debernardi, P., "Reduced Dimensionality Multiphysics Model for Efficient VCSEL Optimization", *Appl. Sci.* 11 (15), 6908, **2021**. doi: 10.3390/app11156908

Conferences

[3] Tibaldi, A., Gullino, A., Gonzalez Montoya, J. A., *et al.*, "Modeling Tunnel Junctions for VCSELs: A Self-Consistent NEGF-DD Approach", proceedings of *2020 International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD)*, 67-68, Turin (Online), Italy, September 14-18, **2020**. doi: 10.1109/NUSOD49422.2020.9217684

[4] Gullino, A., Tibaldi, A., Bertazzi, F., Debernardi, P., *et al.*, "Modulation response of VCSELs: a physics-based simulation approach", proceedings of *2020 International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD)*, 65-66, Turin (Online), Italy, Sept. 14-18, **2020**. doi: 10.1109/NUSOD49422.2020.9217650

[5] Gullino, A., Pecora, S., Tibaldi, A., Bertazzi, F., Goano, M., Debernardi, P., "Oxide-Confined vs. Buried Tunnel Junction VCSELs", *European Semiconductor Laser Workshop*, Paris (Online), France, Sept. 17-18, **2021**

[6] Gullino, A., Pecora, S., Tibaldi, A., Bertazzi, F., Goano, M., Debernardi, P., "A multiscale approach for BTJ-VCSEL electro-optical analysis", proceedings of *2021 International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD)*, 79-80, Turin (Online), Italy, Sept. 12-16, **2022**. doi: 10.1109/NUSOD52207.2021.9541423

[7] D'Alessandro, M., Gullino, A., Tibaldi, A., Bertazzi, F., Goano, M., Debernardi, P., "Physics-Based Time-Domain Modeling of VCSELs", proceedings of *2022 International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD)*, 61-62, Turin (Online), Italy, Sept. 13-17, **2022**. doi: 10.1109/NUSOD54938.2022.9894787

[8] Gullino, A., Tibaldi, A., Bertazzi, F., Goano, M., Debernardi, P., "Multiscale and Multiphysics Solvers for AlGaAs TJ-VCSEL", In: Cocorullo, G., Crupi, F., Limiti, E. (eds) *Proceedings of SIE 2022. Lecture Notes in Electrical Engineering*, vol 1005. Springer, Cham., **2023**. doi: 10.1007/978-3-031-26066-7_30

[9] Gullino, A., D'Alessandro, M., Tibaldi, A., Bertazzi, F., Goano, M., Debernardi, P., "Confinement insights in oxide-confined AlGaAs TJ-VCSELs through physics-based approach", *Conferenza SIE 2023*, Noto (CT), Italy, Sept. 5-8, **2023**

[10] Gullino, A., Torrelli, V., D'Alessandro, M., Tibaldi, A., Bertazzi, F., Goano, M., Debernardi, P., "Physics-based modeling of AlGaAs tunnel junction VCSELs: a comparative appraisal", proceedings of *2023 International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD)*, 99-100, Turin, Italy, Sept. 18-21, **2023**. doi: 10.1109/NUSOD59562.2023.10273507

Teaching assignments

2022–2023 **Tutoring** - Electronics Circuits (Prof. M. Goano), at Politecnico di Torino.

Training and workshops

2018–2019 **Workshop** - "A nanotechnological device from modeling to characterization", at Politecnico di Torino, with Prof. Carlo Ricciardi.

Other experiences

2019–2021 **Student Team** – DRAFT PoliTo (draftpolito.it), at Politecnico di Torino. Squad Leader of Deep Learning and Computer Vision (DLCV) group.

2021–Now **Referee** of Optical and Quantum Electronics journal.

2023–Now **Referee** of IEEE Transactions on Electron Devices journal.

2022–2023 **Tutor** for a "Politecnico di Torino–PhotoNext" internship about PCSELs modeling.

2024–Now **Referee** of Photonics Journal.