Seminar announcement

Tuesday, April 16, 2024
2 pm
WSI, Seminar room S 101
Exclusively in person

"Terahertz quantum cascade lasers – State of the art, prospects and challenges"

For over two decades, researchers have been striving to develop terahertz quantum cascade lasers (THz QCLs) that can operate at room temperature. These compact semiconductor THz sources have the potential to transform the fields of communications, medicine, security, and fundamental science. The THz spectral range, which conventional semiconductor electronic and photonic devices cannot access, spans from ~0.5 to ~10 THz. Compared to other THz sources based on nonlinear frequency upconversion and downconversion schemes, THz QCLs offer higher power levels and efficiencies as fundamental oscillators. At cryogenic temperatures, THz QCL systems can achieve watt-level optical power in pulse mode and tens of milliwatts in continuous wave operation with ~1% efficiency. THz QCLs also open a path to developing other THz sources, such as frequency combs, radiation amplifiers, and local oscillators for ultra-sensitive heterodyne detection systems. Until recently, such applications were possible only by using relatively bulky Stirling coolers. In 2021, we demonstrated THz QCL operation at a record-high operating temperature of Tmax ~ 250 K, using a portable and vibration-free thermoelectric (TE) cooler.2 After further optimizations, we improved the Tmax to 261 K. While these achievements are significant, the quest for true room-temperature operation continues. In our presentation, we introduce the THz QCL operating principles, describe the optimization strategies we have used so far, and discuss the challenges related to molecular beam epitaxial growth of such structures. We also speculate on the possible paths for further improvements of these fascinating devices.

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Brief bio

Zbig Wasilewski is a professor in the Electrical and Computer Engineering Department at the University of Waterloo and a Research Chair in Nanotechnology. He is internationally renowned for his contributions to the field of Molecular Beam Epitaxy, quantum-dot and quantum-well photonic devices, and quantum structures and devices based on high-mobility 2D electron gases.

Dr. Wasilewski earned his doctoral degree from the Institute of Physics of the Polish Academy of Sciences in 1986, based on his pioneering research in low-temperature magneto-optical studies of semiconductors under high hydrostatic pressures. In 1988, after a post-doctoral appointment at the Imperial College, London, he joined the National Research Council of Canada (NRC), shifting his research focus to molecular beam epitaxial growth and characterization of quantum structures and devices based on III–V semiconductor compounds. In 2006, Dr. Wasilewski was promoted to Principal Research Officer – NRC's top research rank. In July 2012, Dr. Wasilewski joined the University of Waterloo as a Full Professor and the University of Waterloo Endowed Chair in Nanotechnology, where he established the Quantum-Nano Centre MBE Facility (QNC-MBE). The same year, he was awarded the life title of Professor of Physics by the President of Poland in recognition of his scholarly contributions and his role in developing the field of GaN-based optoelectronics in Poland. In 2022, he was elevated to Fellow of the IEEE.