Graduate Student Positions (PhD) in the Extreme Photonics at Tsuneyuki Ozaki's lab

Location: The research is performed at the Institut national de la recherche scientifique – Centre Énergie Matériaux Télécommunications (INRS-EMT), 1650 blvd. Lionel-Boulet, Varennes (Québec), J3X 1P7, Canada. The students will conduct their research at various facilities at the INRS-EMT, including the Advanced Laser Light Source (ALLS), the most powerful laser in Canada.

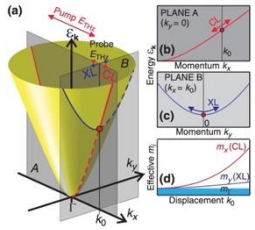
Research Fields: High-order harmonic generation, Advanced Terahertz spectroscopy, Biophotonics.

Project Descriptions

Project #1: Femtosecond high Average-power Micro-joule & Milli-joule Extreme-Ultraviolet Source (FAMEUS)

The recent Nobel Prize in Physics was awarded to Prof. Anne L'Huiller, Prof. Ferenc Krausz and Prof. Pierre Agostini for their works on attosecond pulses generated via a highly nonlinear optical phenomenon called high-order harmonic generation (HHG). At the INRS, we have been developing a novel method of HHG with extremely high conversion efficiencies, much higher than those using conventional methods. In this project, we aim to capitalize on our recent findings to develop HHG sources with the highest average power and highest energy in the world. This research aims to bring intense XUV-matter interaction studies, which currently can only be done at billion-$ facilities such as the X-ray free electron lasers, into modest-sized laboratories, hoping to contribute significantly to promoting the field. The students will also have the chance to work with our international collaborators to use this intense HHG source for various applications, including XUV imaging and pump-probe spectroscopy.

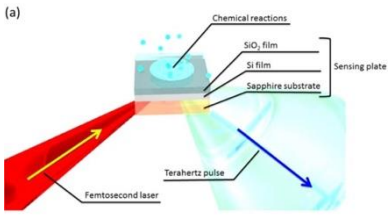
Project #2: Nonlinear Terahertz Photonics



PRL 107, 107401 (2011).

Our group has pioneered nonlinear optics in the far-infrared range, the so-called terahertz (THz) regime. This is a new area in ultrafast photonics, with numerous applications in material science and electronics. Capitalizing on the intense laser beamlines of ALLS, we have been studying the interaction of intense THz pulses with matter, such as graphene and various semiconductors. We have also developed several codes to model our experimental observations. In this project, the student will work with current members of our group to further our understanding of various nonlinear THz effects, such as THz high-order harmonics. The students will first work on developing the intense THz source, and then apply the developed source to study nonlinear THz phenomena.

Project #3: High-sensitivity, high-throughput Terahertz Sensor for Biology & Medicine



In collaboration with Prof. Toshihiko Kiwa (Okayama U, Japan), we have developed a novel sensor based on advanced THz technology, called the THz Chemical Microscope (TCM). The TCM is versatile, has high sensitivity and can detect substances at speeds that are much higher than conventional techniques. We have used the TCM to detect breast cancer cells, demonstrating a limit-of-detection of 1 breast cancer cell in 0.1 mL of sample. Such a TCM could be used to noninvasively monitor the outcome of cancer treatments while minimizing adverse side effects. The TCM has also been applied to monitor environmental toxins, and we are currently working on unravelling the enigma behind Alzheimer's disease. In this project, the student will first work to further improve the performance of the TCM in terms of sensitivity and data acquisition speed. The student will also work with researchers in biology, medicine and environmental sciences to bring the TCM from bench to bedside.

Funding: All projects are fully funded. Nevertheless, the candidates are strongly recommended to apply for various scholarships, such as those from NSERC and the FRQNT.

Admissibility: Students in Physics, Engineering Physics or other relevant disciplines are invited to apply. Knowledge in optics/photonics and programming is an asset. A good knowledge of English is required.

To apply: Interested candidates should send their CV, a copy of their most recent transcripts and a motivation letter to Tsuneyuki Ozaki (tsuneyuki.ozaki@inrs.ca).