Mid-IR and THz Chemical Sensing and Hyperspectral Imaging With Semiconductor Frequency Combs

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Bowen Hall, Room 222

MAE Seminar Series

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Semiconductor quantum cascade laser frequency combs (QCL-FCs) have recently shown tremendous potential as spectroscopic sources. By simultaneously providing relatively broadband spectral coverage and narrow linewidths in the mid-IR and THz spectral region, they enable detection of chemicals with broadband absorption spectra and high-spectral resolution spectroscopy of gas molecules. Such semiconductor laser comb sources show unique potential for integration into lab-on-chip systems and into transportable/portable sensing systems for field applications.

I will present a dual-comb spectroscopy (DCS) technique that has been implemented to perform spectroscopic sensing with QCL combs. DCS provides nearly-instantaneous access to optical information across the entire spectral bandwidth provided by the comb sources, which drastically reduces the required acquisition time per spectra. In order to enable reliable DCS with QCL-FCs we utilize high-speed phase and timing correction algorithms to allow for computational coherent averaging. Prototype spectroscopic systems based on this technology for in-situ detection of chemical vapors as well as remote detection and localization of chemical plumes have been enabled by the quantum cascade laser frequency combs.

In this talk I will present DCS systems based on semiconductor sources operating in the mid-IR (up to ~10μm) and THz (~3THz) that are used to perform spectroscopy of gases and hyperspectral imaging of solids. Examples of fast DCS with temporal resolution down to 10μs/spectrum as well as future directions towards integrated photonics DCS systems will be discussed.

Gerard Wysocki is an Associate Professor of Electrical and Computer Engineering at Princeton University. He received his PhD degree from Johannes Kepler University in Linz, Austria and his MS degree in optoelectronics from the Wroclaw University of Technology in Poland. Wysocki conducts research in the area of mid-infrared and THz photonic sensing, broadband tunable mid-infrared lasers and frequency combs, and novel spectroscopic techniques for in-situ and remote chemical detection. For his scientific contributions and technical innovations, Wysocki has received multiple awards including the NSF CAREER Award, the Masao Horiba Award for contributions to analytical science, and the Peter Werle Early Career Scientist Award. He is a member of OSA, APS, and SPIE and serves as an Associate Editor of Optica, and Co-editor of Applied Physics B

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