Multi-watt terahertz semiconductor lasers

Speaker: **Sushil Kumar, Lehigh University**

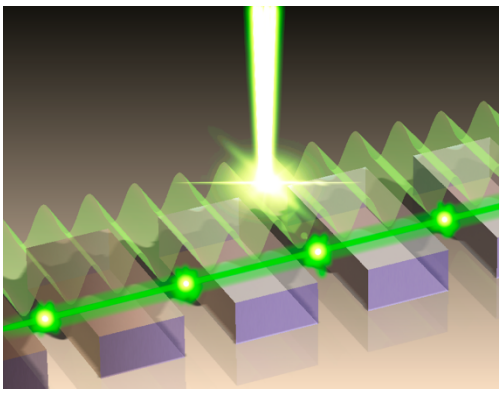
electron devices society

Cornell University
School of Electrical and Computer Engineering

Abstract :

Terahertz (THz) semiconductor quantum cascade lasers (QCLs) are arguably the most powerful compact sources of coherent THz radiation. QCLs are based on intersubband optical transitions in semiconductor superlattices. The best performing THz QCLs are designed to emit in the frequency range of 3-4 THz corresponding to wavelengths of 75-100 um. At such long wavelengths, these lasers are best served by the use of parallel-plate metallic cavities for mode confinement, which are similar to the microstrip transmission lines used for channeling radiation at microwave frequencies. Use of metallic cavities, which support optical modes based on surface-plasmon polaritons, lead to unexpected and unique challenges in cavity design owing to the rather poor radiative characteristics of such plasmonic cavities that include low radiative efficiencies, multi-mode lasing behavior, and divergent radiation patterns. This talk will introduce some of the techniques that have been used in literature to realize THz QCLs with greater output power with desired spectral behavior and better far-field beams. We will then describe two different types of distributed-feedback and phase-locking schemes developed at our group for surface-emitting THz QCLs that have achieved the record highest output-power for single-mode THz QCLs in pulsed operation to-date. We will also discuss ongoing work on beam combining of multi-spectral laser arrays, and electrical tuning of such QCLs (time permitting). Some preliminary experimental results of THz sensing of analytes in liquid-phase will also be shown, which is an important step toward demonstrating the viability of QCLs for practical applications in THz spectroscopy and sensing.

Bio:



Sushil Kumar performed his Ph.D. thesis research as well as his postdoctoral training at the Massachusetts Institute of Technology, and joined Lehigh University's ECE faculty in the fall of 2010, where he is now an Associate Professor in the Department of Electrical and Computer Engineering. His work is on the development of terahertz quantum-cascade lasers (QCLs), which are high-power, coherent, compact and narrowband radiation sources based on intersubband optical transitions in semiconductor superlattices. He has published widely in the area of improvement of the temperature performance and radiative properties of terahertz QCLs including their output power and the study of intersubband optoelectronic transport phenomena in semiconductor heterostructures. His future interests are in addressing terahertz and mid-infrared applications in sensing, imaging, and spectroscopy using high-power QCLs and also intersubband optical detectors. He received the National Science Foundation (NSF) CAREER award in 2014, and his research is currently supported by grants from the NSF.

Virtual Talk
Friday, March 19th, 2021

Talk begins: **12:00pm**

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Partially funded by GPSAFC

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