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# Photonic engineering and micro-cavity tuning of THz quantum cascade laser resonators

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Terahertz (THz) radiation lies in the region of the electromagnetic spectrum, loosely defined as the 30-300 μm wavelength region that is often called "THz gap". Recent technological innovation in photonics and nanotechnology is now enabling THz frequency research to be applied in an increasingly widespread range of applications, such as information and communications technology, sensing, medical diagnostics, global environmental monitoring, homeland security, and quality and process controls. Most of these applications require systems with targeted sensitivity and specificity exploiting advanced quantum devices, novel materials and technologies. To address the above application requirements, high power, widely tunable sources with controlled and directional beam profiles, together with high-speed and high-sensitivity resonant detectors need to be developed. This requires parallel developments in semiconductor materials and hetero structures, including micro/nano structuring and plasmonics, as well as related multifunctional THz optical components. The talk will provide an overview of our recent technological developments of Terahertz quantum cascade lasers, from the development of quasi-crystal THz intersubb and lasers, 1. To novel DFB concepts exploiting bi-period feedback gratings to control the emission frequency and the output beam direction independently. 2. A final emphasis on our micro cavity approaches for continuous tuning of THz QCL emission and waveguide adapters for efficient THz radiation out-coupling will be provided.

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