

QUANTUM CASCADE LASERS

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Quantum cascade lasers (QCLs) are heterostructures made (in this case) from materials in the III-V semiconductor group (e.g., GaAs/GaAlAs). A heterostructure is a multiple quantum well (MQW) planar structure of alternating high and low gap materials. THz photons are emitted by these devices as electrons make transitions between sub-band states in the conduction band. A large number of repeating MQW sections are cascaded during MBE layer deposition to enhance the gain path. A single electron traveling through this composite structure under DC bias emits hundreds of identical THz photons without recombination (in contrast to a single photon per recombination in a bipolar diode laser). With the addition of optical feedback from the cleaved ends of the MQW gain region, the device acts as a laser. TM selection rules for these type II superlattices dictate that the emission emanates from the edge facet of the device (i.e., perpendicular to the MBE growth direction) with a polarization parallel to the growth direction.

The demonstration of practical quantum cascade lasers at frequencies between 2-5 THz in the last few years has filled the need for a fundamental signal source in this spectral region. Already THz QCLs have produced output powers exceeding 10 mW, linewidths less than 100 kHz, and CW operating temperatures above 100 K, although these parameters have not yet been achieved simultaneously. Nevertheless, QCLs have already been employed successfully as LOs in THz receivers using NbN HEB mixers. This talk will summarize the current state of the art in QCLs designed for LO applications, and outline development goals for the next few years.

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