Quantum and Interband Cascade Lasers with Applications

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Quantum and interband cascade lasers (QCLs and ICLs) have become important scientific and commercial technologies following their first laboratory demonstrations in 1994 and 1997, respectively. Interest has continued to accelerate since the previous special section devoted to this topic appeared in Optical Engineering in 2010. One indicator is the rapid growth of “cascade laser” citations in the scientific literature, now exceeding 6000 per year. Of course, the dramatic expansion of cascade laser publications strongly correlates with novel advances in the device architectures, laser performance, and applications. This new special section of Optical Engineering on “Quantum and Interband Cascade Lasers with Applications” provides an overview of the status of this dynamic research topic, and attempts to capture the most recent scientific developments.

When the special section call for papers was issued in the spring of 2017, critical new progress had already occurred since the 2010 edition. This included the evolution of continuous-wave output powers from single watts to tens of watts generated by QCL arrays, the application of nonlinear difference frequency generation to produce THz radiation at room temperature, single-mode QCLs and ICLs with sufficient maturity for routine incorporation into commercial chemical sensing systems, and frequency combs based on both QCL and ICL emission. By inviting new papers contributed by many of the leading QCL and ICL research groups, our intention is not simply to survey the recent progress of these technologies, but also to outline new directions for the near future and beyond.

The 21 papers in this special section push the boundaries of device performance into several previously unexplored regions of interest. Examples include low-threshold ICLs emitting at wavelengths beyond 6 μm, high-power quantum cascade superluminescent emitters, and THz QCLs operating at ambient temperature. Of special interest at this stage are the integration and miniaturization of QCL and ICL devices and systems. Several of the papers focus on integrated laser/detector systems, micro-opto-electromechanical frequency tuning, and fully monolithic systems for broad QCL frequency tunability. THz QCLs based on difference frequency generation have been transferred to silicon substrates, and also provide surface emission. Other papers investigate the device dynamics of QCL frequency combs, and apply ICL frequency combs to multiheterodyne chemical spectroscopy. Novel chemical detection technologies include stand-off detection with swept external-cavity lasers, and the application of multi-emitter ICL architectures to absorption spectroscopy.

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References


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