High-Power Quantum Cascade Lasers for Single, In-Phase Mode Operation

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WARF: P110160US01

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a method for suppressing oscillation in an array mode composed of coupled first-order element modes in semiconductor laser array devices.

Overview

UW–Madison researchers previously developed high-power quantum cascade lasers (QCLs) with active-photonic-crystal structures to provide improved high-power, narrow-beam laser sources that operate in the mid- to long-wavelength range (see WARF reference number P09338US01). These lasers have applications in homeland security, laser photo-acoustic spectroscopy, missile-avoidance systems, medical diagnostics and free-space communications.

The element regions of these laser structures are characterized by a uniform structure across their widths. As a result, an array mode made of out-of-phase coupled first-order element modes is present, i.e., it is not suppressed by loss in the interelement regions of the array. A method for suppressing lasing in the out-of-phase mode is needed to ensure efficient single-mode operation of the laser-array structure in the desired in-phase mode.

The Invention

UW–Madison researchers now have developed a method to suppress oscillation of the array mode composed of coupled first-order elements modes, which will allow high-power quantum cascade lasers to perform at an optimal single in-phase mode. The structure of the laser array device includes an optical confinement structure comprising at least one layer of optical confinement material above and below the quantum cascade laser structure, a cladding structure and laterally spaced trench regions extending into the quantum cascade laser structure. The device is designed to produce an array mode composed of coupled fundamental lateral element modes meeting a lateral resonance condition that enables strong coupling between the “leaky waves” of all element regions. Two embodiments are possible.

The first embodiment requires an added metal absorption loss region layer above the element region and removes material from the element edges to induce losses in the transverse direction for the first-order mode.This induced loss is absorption of light by the layer deposited above the element region. The second embodiment inserts a diffraction grating inside or at the top of each element region over only a portion of the region. The gratings provide preferential feedback for array modes composed of coupled first-order element modes to assure high power in the desired in-phase mode. Either method removes the out-of-phase mode and allows optimal performance of a quantum cascade laser.

Applications

- Environmental monitoring
- Military applications
- Communications
- Remote sensing of gases or other harmful substances

Key Benefits

- Enables suppression of oscillation of array modes composed of coupled first-order lateral modes of the element regions to ensure optimal laser performance

Additional Information

For More Information About the Inventors

- Dan Botez

Related Technologies

- For more information about high-powered quantum-cascade lasers with active photonic crystal structure previously developed by the inventors, see WARF reference number P09338US01.
- For information about high-power, high-efficiency quantum cascade lasers, see WARF reference number P100284US01.

Tech Fields

- Analytical Instrumentation, Methods & Materials : Lasers

For current licensing status, please contact Michael Carey at mcarey@warf.org or 608-960-9867