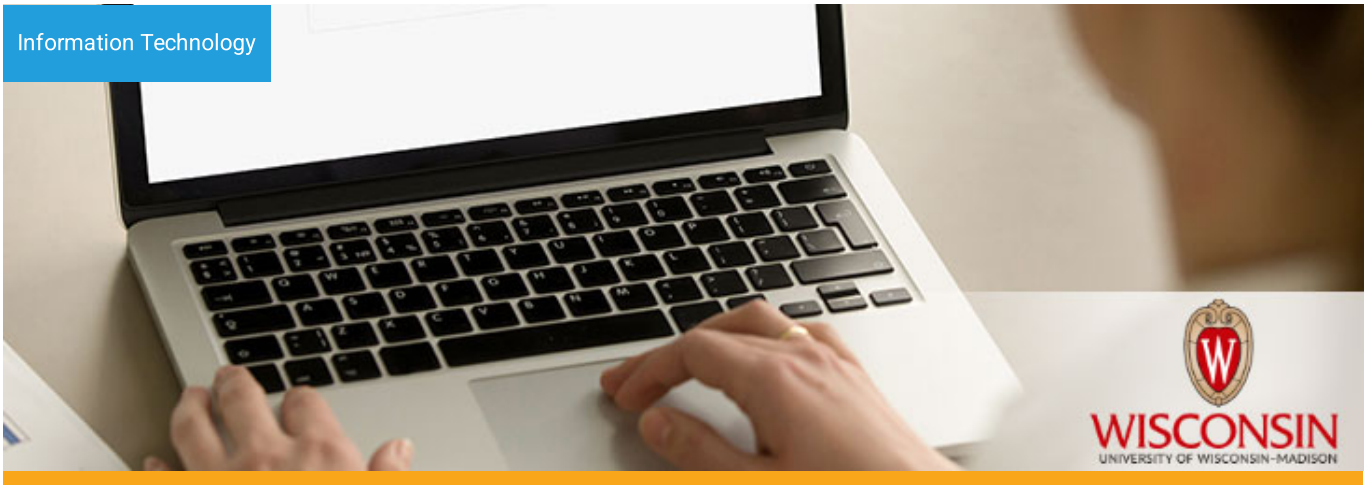
Information Technology



More Efficient Semiconductor Lasers

View U.S. Patent No. 9,093,821 in PDF format.

WARF: P140047US01

Inventors: Luke Mawst, Dan Botez, Thomas Earles, Jeremy Kirch, Christopher Sigler

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing quantum cascade lasers that can operate in the desired symmetric mode without the need for phase shifters or complex optics.

Overview

Quantum cascade lasers (QCLs) are semiconductor lasers that provide light in the mid- and far-infrared wavelength ranges. They are designed so that the generated light is transverse-magnetic (TM) polarized. They can be made using first-order distributed feedback gratings. While this design provides desirable single-mode emission, the lasers are edge-emitting (i.e., laser light is emitted from a cleaved facet).

To eliminate the need for cleaved facets (which are expensive and complex to manufacture), second-order distributed feedback gratings may be used instead. However, these QCLs generally operate in an antisymmetric longitudinal mode, resulting in a double-lobe, far-field pattern. To achieve a desired single-lobe beam pattern, a phase shifter may be used. Still, problems include inefficiency and low potential for continuous-wave (CW) operation at high output powers.

The Invention

UW–Madison researchers have taken a new approach and developed QCLs configured for symmetric longitudinal mode (single-lobe beams) with no loss in efficiency. Instead of relying on phase shifters, the new lasers work by suppressing undesired antisymmetric longitudinal modes.

The lasers are made of layers of cladding, metal (such as gold or silver) and indium phosphide-based semiconductor material. The interface of the metal and semiconductor layers forms a corrugated, second-order distributed feedback grating, which absorbs the undesired antisymmetric longitudinal modes. This configuration eliminates the need for cleaved facets.

Applications

- Medical imaging
- Materials processing
- Remote sensing and infrared countermeasures
- Free-space optical communications

Key Benefits

- Increased outcoupling efficiency and high output power CW operation
- No cleaved facets
- No phase shifters or complex gratings
- Easier and cheaper to manufacture

Stage of Development

The new lasers emit single-lobe, far-field beam patterns and a wavelength in the range of about 4 to 5 microns.

Additional Information

For More Information About the Inventors

- Luke Mawst
- Dan Botez

Related Technologies

- WARF reference number P110156US01 describes QCLs with improved device performance and emission wavelengths less than four microns.
- WARF reference number P120315US01 describes more efficient and reliable high powered QCLs.

Publications

- Sigler C., Kirch J.D., Earles T., Mawst L.J., Yu Z. and Botez D. 2014. Design for High-Power, Single-Lobe, Grating-Surface-Emitting Quantum Cascade Lasers Enabled by Plasmon-Enhanced Absorption of Antisymmetric Modes. Appl. Phys. Lett. 104, 131108.

Tech Fields

- Analytical Instrumentation, Methods & Materials : Lasers
- Information Technology : Networking & telecommunications

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