Analytical Instrumentation, Methods & Materials

Intersubband Semiconductor Lasers That Operate Reliably at Room Temperature and in the Mid-Infrared

View U.S. Patent No. 7,558,305 in PDF format.

WARF: P04199US

Inventors: Dan Botez, Ali Mirabedini, Dapeng Xu, Luke Mawst

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing the first reliable semiconductor laser operating in the mid-infrared region.

Overview

Intersubband semiconductor lasers represent a new type of laser that emits photons when electrons within a quantum-well structure release their energy during transit from high- to low-energy states. Achieving room temperature continuous wave (CW) operation of these lasers at mid-infrared wavelengths (3-5 microns) involves the use of multiple-stage devices called quantum-cascade lasers (QCLs). However, conventional QCLs emitting in the mid-infrared, which are made of InP-based materials, tend to leak carriers. This in turn causes thermal runaway and quick device degradation at room temperature. In addition, in GaAs-based QC devices at high transition energies, the laser's active region is depopulated due to resonant tunneling between the X valleys of the surrounding barriers, a problem that limits the laser's room temperature operation to wavelengths longer than 8 microns.

The Invention

UW-Madison researchers have now developed a GaAs-based, quantum-cascade, intersubband semiconductor laser that suppresses virtually all carrier leakage, a feature that makes this device thermally stable during CW operation at room temperature and thus provides the first reliable semiconductor laser operating in the mid-infrared region. The device consists of very deep InGaAs quantum wells sandwiched between very high AlGaAs barrier layers, a structure that tightly confines injected carriers. This structure also prevents resonant tunneling between the X valleys of the surrounding barriers at high transition energies, a feature that also makes room temperature, mid-infrared emission possible in a GaAs device for the very first time.

Applications

- Room temperature operation of GaAs-based lasers

Key Benefits

- Makes room temperature operation of GaAs-based lasers in the mid-infrared (3-5 micron) possible for the first time
- Also makes reliable CW operation of semiconductor lasers in the mid-infrared possible for the first time
- Promises to increase the efficiency of far-infrared (8-12 micron) laser emission
- Simpler and less expensive to manufacture: Devices can be fabricated with low-pressure MOCVD (metal organic chemical vapor deposition) rather than molecular beam epitaxy (MBE)
- GaAs-based laser technology is significantly more mature than InP-based technology

Additional Information

For More Information About the Inventors

- Dan Botez
- Luke Mawst

Tech Fields

- Analytical Instrumentation, Methods & Materials : Lasers

For current licensing status, please contact Jeanine Burmania at jeanine@warf.org or 608-960-9846