Larger-area Single-mode Photonic Crystal Surface-emitting Lasers Enabled by the Accidental Dirac-point

Technology #15692

Applications

Applications for this technology are currently found in telecommunications, spectroscopy, laser printing, biological tissue analysis, and meteorology.

Problem Addressed

Distributed feedback (DFB) lasers and vertical-cavity surface-emitting lasers (VCSELs) rely on one-dimensional feedback structures to provide relatively high-power, single-mode beams. Unfortunately, these lasers suffer from intrinsic drawbacks: DFB lasers and other edge-emitting sources tend to suffer from catastrophic optical damage at their facets, and the VCSELs' output powers are usually limited by their small cavity sizes.

On the other hand, conventional photonic-crystal surface-emitting lasers (PCSELs), have a higher functionality than the previously mentioned lasers. However, the lasing areas of PCSELs are limited by two fundamental constraints. First, the mode spacing decreases as the cavity area increases, which promotes multi-mode lasing. Second, the distributed in-plane feedback localizes the lasing fields to individual sections, which promotes multi-area lasing. Since the output power scales with the lasing area, these constraints limit the maximum output power of a single-mode beam emitted by a PCSEL.

Technology

This invention exhibits a photonic-crystal surface-emitting laser (PCSEL) with an accidental Dirac point. PCSELs include a gain medium electromagnetically coupled to a photonic crystal; however, in this invention, the energy band structure exhibits a Dirac cone of linear dispersion at the center of the photonic crystal's Brillouin zone. Because the Dirac point is at the Brillouin zone center, it is called an accidental Dirac point. This is of great importance because tuning the photonic crystal's band structure (e.g., by changing the photonic crystal's dimensions or refractive index) to exhibit an accidental Dirac point increases the photonic crystal's mode spacing by orders of magnitudes and reduces or eliminates the photonic crystal's distributed in-plane feedback. Thus, the photonic crystal can act as a resonator that supports single-mode output from the PCSEL over a larger area than is possible with conventional PCSELs, which have quadratic band edge dispersion. Because output power generally scales with output area, this increase in output area results in higher possible output powers.

Advantages

- Increased orders of magnitude in photonic crystal mode spacing
- Reduction in the crystal's distributed in-plane feedback
- Greater output power and output area

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Categories For This Invention:

Photonics
Sensors (Photonics)
Spectroscopy (Sensors)
Telecommunications

Intellectual Property:

Photonic crystal surface-emitting lasers
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Photonic crystal surface-emitting lasers enabled by an accidental Dirac point
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Image Gallery:

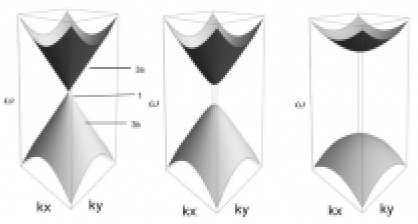

FIG. 1A FIG. 1B FIG. 1C

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