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# Modification of Vertical Cavity Surface Emitting Laser Emission Characteristics

**IP Status:** Issued US Patent; **Application #:** 09/954,510

**Technology ID**
z01027

**Category**
Engineering & Physical Sciences/Semiconductor
Software & IT/Communications & Networking

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### Single Mode Confinement VCSEL

A vertical cavity surface emitting laser (VCSEL) offers single mode confinement. The VCSEL is comprised of a substrate and a lower mirror, active region and upper mirror arranged in a vertical stack to form a laser. Horizontally spaced-apart regions of increased refractive index extend vertically at least partially through the vertical stack to promote single-mode confinement in the stack. The VCSEL also features an etalon structure for tuning, an increased index of refraction region which is not circular in cross-section, and a plurality of concentric rings around the core. Single-mode confinement in the mirror region of the laser is ensured by etching or implantation to obtain a photonic band gap VCSEL structure. A modified implantation and etching technique ensures that emission of the VCSEL has a fixed polarization, effective in both single mode and multimode. Modifying the VCSEL with an etalon structure allows the wavelength of emission to the single-mode VCSEL to be tuned. Applying aspects of the "holey fiber" concept used in optical silica fibers (where air holes are periodically placed along the length of silica fibers) reduces the effective index of refraction of the region with holes and determines the pass-bands and stop-bands for the wavelengths that can and cannot propagate through the structure (i.e., the photonic bandgap, or PBG, effect).

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### Single Transverse Mode Operation

Current VCSEL performance suffers from small power levels. Previous attempts to increase VCSEL power output have tried increasing the VCSEL's diameter. However, increased diameters have led to undesirable consequences. The devices tend to oscillate in several different transverse modes, resulting in the emission of light with as many wavelengths as there are modes. The single transverse mode operation in this technology mitigates two issues: 1) light from multiple transverse mode sources cannot be focused efficiently, so coupling two devices such as single mode fiber amplifiers is inefficient, and 2) multiple wavelengths corresponding to

the various transverse modes significantly compromise the operation of wavelength-sensitive systems such as single-mode optical fiber communication.

**BENEFITS AND FEATURES:**

- Single mode confinement
- Lower mirror, active region and upper mirror arranged in a vertical stack form a laser
- Etalon structure for tuning
- Fixed polarization, effective in both single mode and multimode
- Horizontally spaced-apart regions of increased refractive index
- Aspects of “holey fiber” used in optical silica fibers
- VCSEL devices can be tested before packaging

**APPLICATIONS:**

- Electro-optic systems
- Lasers
- Fiber optic communications
- Precision sensing
- Computer mice
- Laser printers

**Phase of Development** - Proof of Concept.

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