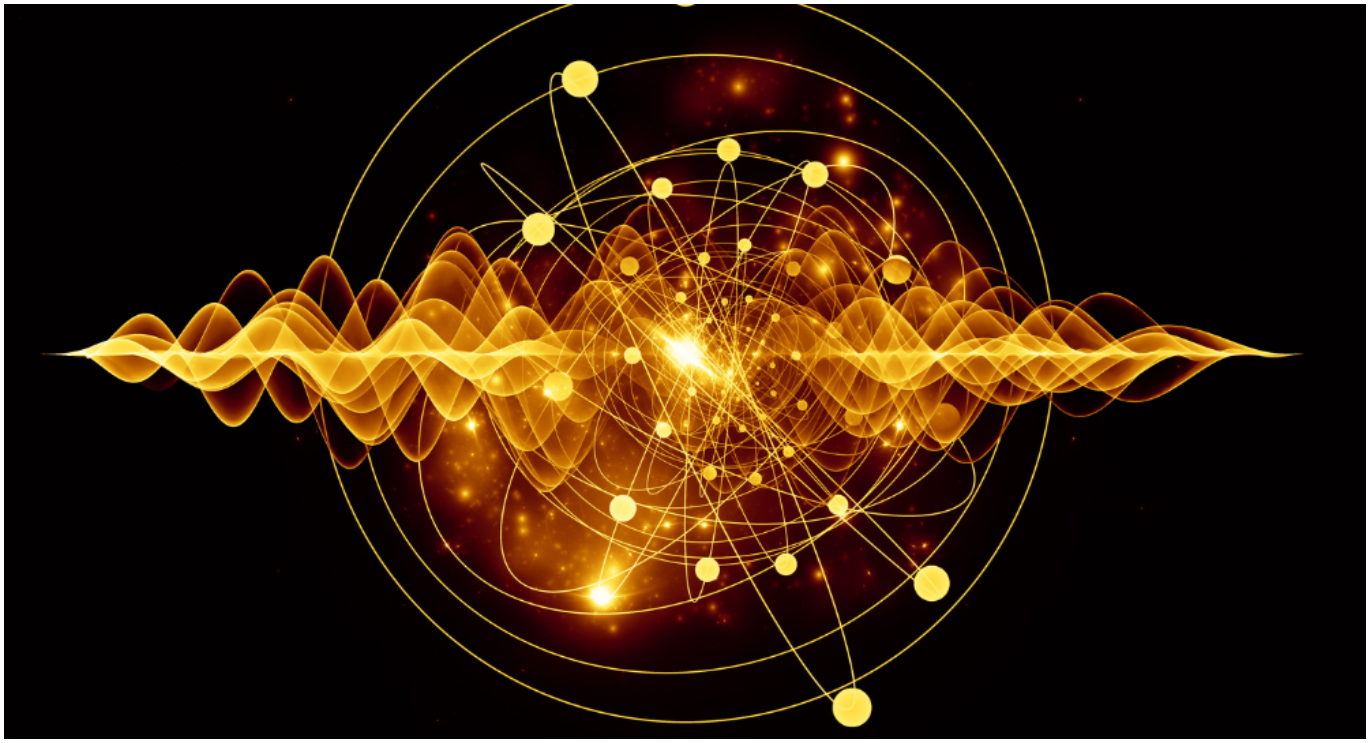
TECH OFFER

High-Power, Narrow kHz Linewidth Lasers for Next Generation Optical Systems



KEY INFORMATION

TECHNOLOGY CATEGORY:
Electronics - Lasers, Optics & Photonics
Electronics - Semiconductors

TECHNOLOGY READINESS LEVEL (TRL): TRL4
COUNTRY: JAPAN
ID NUMBER: TO175266

OVERVIEW

Conventional semiconductor lasers, such as distributed feedback (DFB) lasers, can achieve narrow linewidths but are limited in power output. On the other hand, high-power lasers tend to suffer from broad linewidths due to multimode operation and thermal effects. Narrow-linewidth lasers often rely on external optical feedback systems to reduce frequency range to the kHz or sub-kHz range to increase its precision. While effective, these systems add complexity and cost, requiring precise optical alignment. When the cavity size of conventional semiconductor lasers is increased, multimode lasing typically occurs, which broadens the frequency range and lowers precision as the power output rises. As a result, high-power, narrow frequency range lasers face challenges in scalability due to issues like thermal effects, multimode operation, or the reliance on external stabilization systems.

The technology owner have developed a photonic-crystal surface-emitting lasers (PCSELs) for optical systems that provides high power output (up to 10W) with narrow intrinsic linewidths (~1 kHz), a performance that conventional semiconductor lasers cannot achieve without external stabilization systems. This technology solution intrinsically able to achieve kHz-class linewidth

without the need for external feedback systems, simplifying the design and eliminating the need for complex setups. The photonic crystal design enables single-mode lasing over a large lasing area (1mm in diameter) without compromising on beam quality or frequency spread. This allows PCSELs to be used in high power and high precision applications, such as free-space optical communication and spaceborne LiDAR systems.

The technology owner has demonstrated that by scaling up the lasing area, even higher power and narrower linewidths (<1 kHz) could potentially be achieved. The technology owner is seeking collaboration opportunities with industrial partners looking to explore this next generation optical system for laser and communication applications.

TECHNOLOGY FEATURES & SPECIFICATIONS

The technology solution comprising of the photonic-crystal surface-emitting lasers (PCSELs) for next generation optical system features the following:

- **Double-lattice photonic crystal design** to enable single-mode lasing over a large area, reducing optical losses and ensuring high photon density in the lasing mode.
- Crystal structure includes **distributed Bragg reflectors (DBRs)**, which enhances vertical emission by reflecting downward-emitted light back upward.
- Enables **large-area single-mode lasing (1mm in diameter)** which is larger than conventional semiconductor lasers while maintaining single-mode operation.
- Have a **narrow intrinsic spectral linewidth (1 kHz)** without external feedback systems, ideal for applications requiring stable, narrow-linewidth light sources
- **Reduces thermal non-uniformity** via a current density adjustment, preventing linewidth broadening due to temperature-induced refractive index changes
- **High-power delivery (up to 10W)** of continuous-wave (CW) output while maintaining a narrow linewidth, a significant advancement over conventional lasers which typically sacrifice linewidth for higher power

POTENTIAL APPLICATIONS

Due to the high brightness, high power, and narrow linewidth of any optical systems utilising PCSELs, it can be used for the following applications:

- Industrial machinery utilising lasers (e.g. machining)
- Material treatment utilising lasers for surface modification (e.g. semiconductor equipment)
- Long-distance free-space optical communications
- Light detection and ranging applications with potential spaceborne use-case (e.g. LiDAR)

UNIQUE VALUE PROPOSITION

PCSELs tackles the challenges faced by existing conventional semiconductor lasers by introducing a double-lattice photonic crystal design with distributed Bragg reflectors (DBRs) to deliver a high power and high precision without external feedback via its intrinsic narrow linewidth. This technology solution enables potential scalability with its large-area single-mode lasing capabilities with its innovative thermal management.