Most commercially available quantum cascade lasers (QCLs) are edge-emitting, yet this invention from University of Central Florida involves ring-cavity surface-emitting QCLs (RCSE-QCLs) that are concentrically nested to combine power, coupled to insure coherent emission, and phase controlled with integrated optical delays to engineer the beam profile. This novel method obtains high-power continuous-wave coherent laser radiation at wavelengths from 4 to 20 micrometers and provides a new design approach of a power-scalable, chip-based, high-power, single aperture RCSE-QCL with outstanding beam quality (M2 < 1.2) at infrared wavelengths. This device’s output power is over 15W continuous-waves through a single aperture.

RSCE-QCLs provide large exit apertures with low power densities and stabilized emission wavelengths via second-order distributed feedback, from surface gratings that double as output couplers. Generally, RSCE-QCLs enable wafer-level fabrication and testing, which reduces piece work and handling, which in turn lowers manufacturing costs. Unlike RSCE-QCLs that emit non-Gaussian beams, nested concentric RSCE-QCLs emit more uniform radiation patterns.

**Technical Details**

This RSCE-QCL is comprised of a ring-shaped active region with first and second opposing facets, with at least one of the facets defining a radiation-emitting facet and is aligned with a ring-shaped phase shifter with a spiraled surface. A substrate is located adjacent to the ring-shaped active region and opposite of the emitting facet, and a ring-shaped phase shifter is located on the radiation emitting facet the ring-shaped active region.

**Benefits**

- Outstanding beam quality
- High power
- Low cost design
- More uniform radiation pattern

**Applications**

- Chemical sensing
- Laser communications
- Infrared counter measures
- Ultra-trace gas sensors

**Technology #33010**

- US Patent 9,819,150 B2

**Inventors**

Robert Peale, Ph.D.