

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2020-873

Topic # N182-109

Monolithic high-power QCL-based photonic integrated circuits for two-dimensional beam steering

TransWave Photonics, LLC

WHO

SYSCOM: NAVAIR

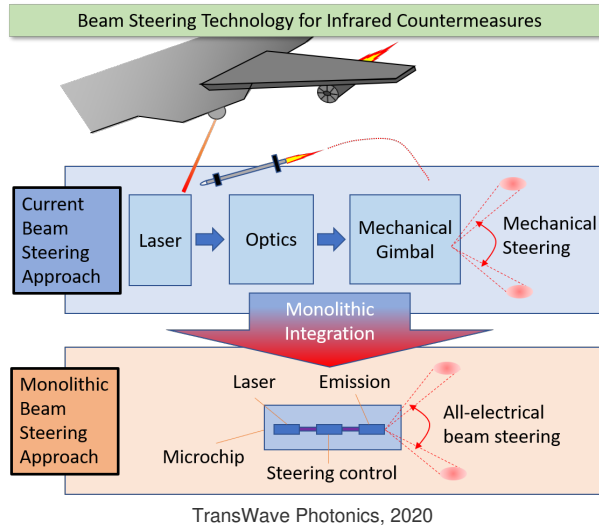
Sponsoring Program: PMA-272
Tactical Aircraft Protection Systems

Transition Target: Infrared Countermeasures System

TPOC:
(760)939-0239

Other transition opportunities:
Military and commercial helicopter and fixed wing aircraft platforms

Notes: We offer a monolithic beam steering device that can be used for an infrared countermeasures system. Unlike the Gimbal-based beam steering system, our monolithic device is ultra-compact, light weight, moving-part-free, and mass-producible, which is expected to significantly improve affordability and applicability of systems requiring infrared countermeasures or beam scanner capabilities.



WHAT

Operational Need and Improvement: Currently, infrared countermeasures (IRCM) systems use a mechanical gimbal mount to steer laser beam to a remote target. Gimbal's size and weight are over 100 times more than the light emitters. In addition, due to the gimbal's mechanical nature, the average steering time of the laser beams is on the order of seconds, which is several orders of magnitude longer than steering via electronic means without any mechanical moving elements. Monolithic steering mechanisms via electronic control with no mechanical moving parts are substantially more robust and reliable. IRCM systems integrating semiconductor lasers plus the steering device as single monolithic integrated unit are not susceptible to shocks, vibrations, and extreme temperature variations.

Specifications Required: Two-dimensional beam steering device, monolithically integrated with a semiconductor laser in a single common semiconductor platform with no mechanically moving components and hybrid integration of any kind. Emit room-temperature continuous wave, Watt-level, mid-infrared output with near diffraction-limited beam quality. Steering angles of the output emission via electronic and non-mechanical control must be at least +/-10 and +/- 25 degrees horizontally and vertically form the surface normal perpendicular to the device's emission surface.

Technology Developed: We have developed a platform where emitters and beam steering elements are monolithically integrated via our proprietary coupling technology. We experimentally demonstrated that our beam steering device can generate and steer laser beam to a target direction over two-dimensional space by all electrical control. The beam steering device consisting a beam controller and a beam outcoupler is demonstrated for two-dimensional beam steering with 1 degree and 6 degrees steering angles along the longitudinal and lateral directions, respectively.

Warfighter Value: Our beam steering device based on a photonic integration technology can potentially reduce cost and size of the existing beam steering device of the IRCM systems more than an order of magnitude. In addition, monolithic nature of our device results in reduction of part/replacement issues and downtime for maintenance as well as improvement in response speed and accuracy as our device does not use any moving parts.

WHEN

Contract Number: N68936-20-C-0033 **Ending on:** April 26, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Subsystem verification 1: Beam steering along horizontal direction	Med	Performance validation	2	September 2020
Subsystem verification 2: Beam steering along vertical direction	Med	Performance validation	2	December 2020
System integration: Two dimensional beam steering under pulsed mode	High	Performance validation	3	April 2021
System integration: Two dimensional beam steering under continuous wave mode (In Phase II Option)	High	Performance validation	4	October 2022
Prototype optimization (Phase II Option ~ Phase II.5)	Med	Performance validation	5	October 2023
Testing of system with fully integrated and packaged platform (In Phase II.5)	Med	Successful testing	6	October 2024

HOW

Projected Business Model: TransWave Photonics aims to transition our beam steerer into Government and Prime contractor systems for infrared countermeasures. As we accomplish our milestone and improve TRL, we will deliver our device to potential customers for testing. As it can be designed for a modular system, our device can be easily incorporated into the existing systems. Testing results and feedback will be assessed and reflected to improve compatibility, quality, reliability, and performance of our device. Producing a number of devices with reasonable timeline is highly feasible as we use a standard fabrication process suitable for mass production.

Company Objectives: Conventional mid-infrared systems are built based on an assembly of discrete components such as light sources, detectors, free space optics, moving mirrors, etc. As a result, such systems are invariably bulky, expensive, and inefficient. Our mission is to deliver miniaturized mid-infrared systems where all active and passive photonic components are monolithically integrated for unmatched size, weight, efficiency, reliability, and functionality. Photonic systems that we develop, customize, or prototype find various applications including communications, integrated sensing, biomedicine, environmental monitoring, and defense and homeland security.

Potential Commercial Applications: Our photonic integration technology can be employed for various commercial applications including widely tunable single frequency laser systems, light detection and ranging for UAVs, compact spectroscopy systems, mid-infrared free-space communication systems, and compact breath analysis systems. For example, UAVs with limited payload can be integrated with our monolithic beam steering or LIDAR system to expand its capability beyond what is currently capable, which is not possible with the current gimbal-based steerers due to the size, weight and power requirement. A sensing system integrated with a laser, a detection, and a sensing element can be developed to offer high specificity and detection level.

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