Department of the Navy SBIR/STTR Transition Program

Distribution Statement A: Approved for public release, distribution is unlimited.
NAVAIR 2016-777

Topic # N142-093
High-Power Mid-Infrared Quantum Cascade Laser Array with Continuous-Wave Output Power Exceeding 100W
TeraDiode, Inc. / Forward Photonics

WHO

SYSCOM: NAVAIR

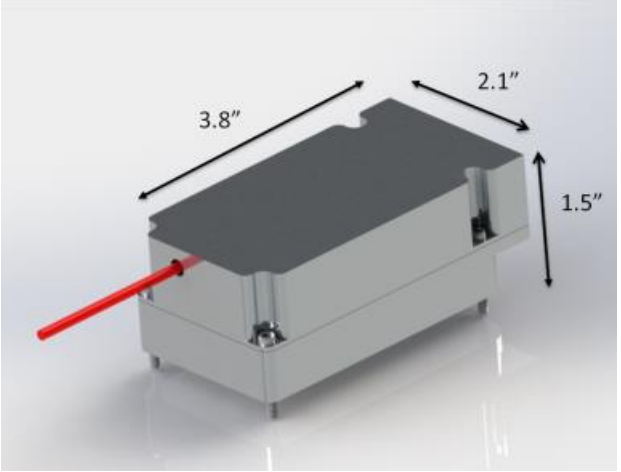
Sponsoring Program: PMA272

Transition Target: Common Infrared Countermeasures (CIRCM)

TPOC:
(760)939- 0239

Other transition opportunities: Distributed Aperture Infrared Countermeasures (DAIRCM)

Notes: Image description - Conceptual design of an extremely compact MWIR laser module, with nearly diffraction limited output, based on a QCL bar. TeraDiode, Inc. was established in 2009 as a spin-off from MIT's Lincoln Laboratory and manufactures high brightness diode and semiconductor lasers for industrial and defense applications using its patented Wavelength Beam Combining (WBC) technology.



Copyright 2016, Teradiode, Inc.

WHAT

Operational Need and Improvement: High brightness mid-wave infrared (MWIR) lasers are extremely important for the next generation of infrared countermeasure (IRCM) applications. By developing quantum cascade laser (QCL) bar technology, and using wavelength beam combination (WBC), we can build IRCM lasers with orders of magnitude higher brightness than existing products. This will put more power on target, even over long paths through the atmosphere, and increase the effectiveness of IRCM systems.

Specifications Required: The goal of this program is to demonstrate a QCL bar package capable of 100 W of total output power. Using WBC, we will combine the QCL bar's output into a single output beam of ~100 W, and with excellent beam quality ($M^2 < 2$). The final goal is to stack multiple bars, and scale the system up to ~1 kW. Due to the extreme heat dissipation requirements, the bars will experience unusually high stresses, so developing techniques to ensure system reliability will also be a key focus of the project.

Technology Developed: Under this program, we have developed several novel QCL bar packaging methods. The QCL bars are packaged on the highest performance micro-impingement heat sinks available. Each emitter is individually addressed to prevent the failure of any individual emitter from compromising the performance of the rest of the bar. Non-destructive testing methods have been developed to evaluate the thermal performance of each packaged QCL bar we produce. We are also continuing to develop our own QCL material in order to greatly reduce the cost of QCL bars in the future.

Warfighter Value: MWIR QCL bars and stacks will be able to produce orders of magnitude higher brightness than current MWIR sources, allowing us to build much more compact and powerful IRCM laser systems. These laser systems could eventually be scaled up to ~1 kW. QCL bars can also be manufactured at any wavelength that single emitter QCLs are currently available, which covers much of the mid-wave and long-wave infrared region. Using QCL bars, we will be able to build laser systems for IRCM with unprecedented brightness and compact size.

WHEN

Contract Number: N68936-16-C-0027 **Ending on:** February 19, 2017

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Develop high performance QCL bar packaging	N/A	Output power and thermal measurements	4	January 2016
Package QCL bars using TeraDiode QCL material	Low	QCL bar output power	4	September 2016
Improve QCL bar packaging consistency	Med	Thermal performance measurements	4	November 2016
Grow and demonstrate 100 W bar material	Med	Output power and thermal measurements	4	January 2017

HOW

Projected Business Model: TeraDiode plans to manufacture infrared laser modules, based on QCL bars and stacks, in high volume for DoD programs, as well as dual-use commercial programs. Transition can be directly to the DoD and/or to the Prime and/or Sub-component Supplier.

Company Objectives: TeraDiode, Inc. is the leading high brightness direct diode laser company in the United States, producing 8 kW industrial lasers for metal cutting and welding applications. We are also introducing a high brightness line of MWIR lasers for both defense and commercial applications.

Potential Commercial Applications: The final product will be an extremely compact, high brightness MWIR laser module customized for Navy applications. This technology has many electronic warfare (EW) applications throughout the DoD. The QCL bar-based laser modules developed under this SBIR program are intended to be dual-use for commercial and military applications including target illumination and detection, EW, terrain/object/building mapping, surveillance, construction, chemical and biological sensing, LADAR, optical communications, and cutting and welding of certain kinds of glass and plastic materials.

Contact: Dr. Robin Huang, VP Defense
robin@teradiode.com (978) 988-1040 x102