Department of the Navy SBIR/STTR Transition Program

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ONR Approval #0543-1020-23

Topic # N19A-T023
Photonic-Integrated-Circuit Spectrometer
Physical Sciences Inc.

WHO

SYSCOM: ONR

Sponsoring Program: ONR

Transition Target: ONR

TPOC: Benjamin Conley
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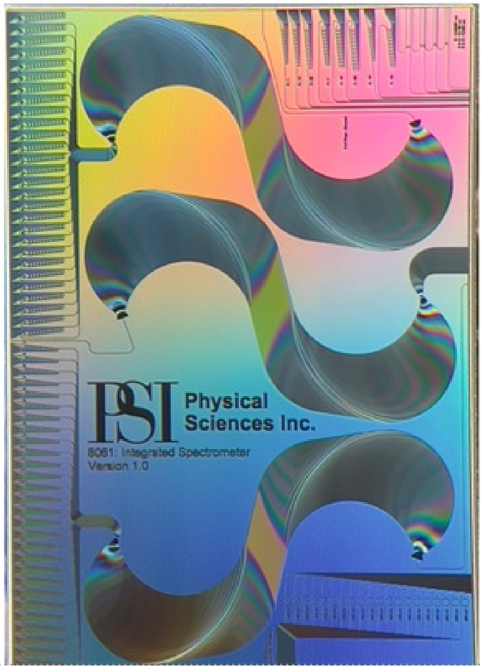
Other Transition Opportunities:
Law enforcement, healthcare, and diagnostics

Notes:
Physical Science Inc.'s (PSI's) dual-stage spectrometer achieves wide bandwidths and high resolutions within a compact, chip-based form-factor that is highly manufacturable.



WHAT

Operational Need and Improvement:
Spectrometers are key laboratory tools for many applications such as molecular identification using Raman spectroscopy. However, addressing these applications in field-deployable scenarios requires significant size, weight, and power (SWaP) reduction from current bulk-optic techniques. Photonic integrated circuits (PICs) are an attractive alternative to bulk-optic spectrometers because they are extremely low SWaP, are readily mass-produced, and can be ruggedized for field deployment. However, typical PIC-based spectrometers are unable to simultaneously deliver the resolution and bandwidth required for key applications. Our unique approach overcomes such limitations using a straightforward and scalable approach.

Specifications Required:
For Raman spectroscopy using a 780-nm pump wavelength within the "molecular fingerprinting" region, the spectrometer must respond between 810–890 nm with sub-nanometer resolution (~0.5 nm).

Technology Developed:
To achieve high resolution over a wide bandwidth we combine two separate techniques to realize a cascaded spectrometer design. This design consists of an arrayed waveguide grating, to provide coarse spectral separation, followed by a series of fine-spectrometer banks that utilize coupled-resonator optical waveguides (CROWs). The series combination of these photonic elements produces a spectrometer with a bandwidth of 125 nm with a resolution of 0.5 nm.

Warfighter Value:
Our approach results in a spectrometer that is well matched to waveguide-enhanced Raman spectroscopy within a low SWaP form-factor that is highly mass producible for wide deployment and reduced cost at scale.

WHEN

Contract Number: N68335-20-C-0571 **Ending on:** Aug 31, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Wide Dandwidth Design	Medium	800–930 nm AWG design	3	3rd QTR FY21
High Resolution Design	Low	0.5 nm resolution resonator design	3	3rd QTR FY21
Chip Fabrication	Low	Fabricated chips	3	4th QTR FY21
Wide Bandwidth Demo	Medium	Measured 805–930 nm	3	1st QTR FY22
High Resolution Demo	Low	Measured bandwidths of 0.5 nm	3	2nd QTR FY22
Cascaded Demo	Medium	Measured cascaded designs	4	4th QTR FY22
Raman Demo	Medium	Demonstrated Raman spectroscopy with chip	4	TBD

HOW

Projected Business Model:
PSI plans to pursue two commercialization approaches:

- Develop building blocks that can be licensed to a commercial foundry and incorporated into their process design kit (PDK), to include these spectrometer into new chip designs
- Manufacture and sell fully-packaged spectrometer units with several variants, from a simple packaged spectrometer to a fully-integrated Raman spectrometer unit.

Company Objectives:
PSI develops advanced technologies and products for the military, aerospace, industrial process, energy, telecommunications, environmental, and medical markets. PSI is strongly committed to developing products based on innovative technologies developed under the SBIR program and has successfully transitioned numerous technologies to support the missions of the Department of Defense, NASA, EPA, and many commercial partners throughout the entire history of the SBIR program.

Potential Commercial Applications:
Portable Raman sensors based on this technology can have commercial applications ranging from pharmaceutical, cosmetic, and agricultural applications to geology and forensics. Meanwhile, our spectrometers are general purpose and can be applied to other sensing modalities (such as fluorescence and absorption spectroscopy for health-care applications) to telecommunications.

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