Department of the Navy SBIR/STTR Transition Program

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Topic # N221-079
Broadband Microlens Arrays for Efficient Coupling into Photonic Imaging Devices
Physical Sciences Inc.

WHO

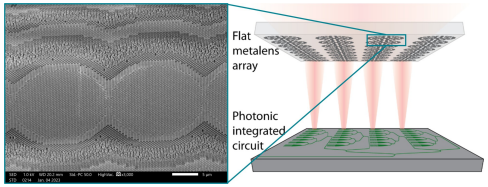
SYSCOM: SSP

Sponsoring Program: Strategic Systems Programs

Transition Target: Trident

TPOC: SSP.SBIR@ssp.navy.mil

Other Transition Opportunities: DoD Markets: Infrared scene projectors
Commercial markets: AR/VR applications, visible DLP projectors, vehicle LIDARs



Notes: PSI is developing a lenslet array based on dielectric metalenses to improve the coupling efficiency of light into grating couplers on a photonic integrated circuit (PIC).
Approach:
PSI's metalens technology will improve the insertion loss characteristics of grating-coupled PICs through:
* Numerical aperture-matching and co-design of the metalenses with the PIC
* Selection of low-loss dielectric materials
* Rational design of the nanoscale elements in the metalens (meta-elements) for low loss and high bandwidth.
The technology can be applied to other optical coupling applications where large lens arrays with tailorable optical performance are needed, such as coupling into PICs, fiber bundles, image sensors, or spatial light modulators. The platform is versatile and can accommodate design degrees of freedom that are unobtainable in a conventional microlens array.

WHAT

Operational Need and Improvement: Phased-array photonic integrated circuits (PICs) are a promising technology for reducing the size, weight, and power (SWaP) requirements of conventional imaging systems. The performance of phased-array imaging PICs is largely limited by input coupling losses into the waveguide circuit. Microlens arrays, consisting of small-aperture refractive lenslets, have been explored as a route to maximizing the optical coupling into a PIC. The manufacture of refractive microlens arrays entails tradeoffs between bandwidth, scattering losses, and cost. This program aims to address the limitations of conventional microlens arrays.

Specifications Required: We are targeting imaging applications in the near-infrared. Our technology performs across 700 - 900 nm bandwidth, with tunable numerical aperture (0.05 to 0.15 demonstrated) with variable aperture size (60 to 250 microns). This capability is delivered in a flat package (thickness 0.7 mm) with high lens placement accuracy.

Technology Developed: Physical Sciences Inc. is developing a Coupling-Optimized Metalens for Broadband Imaging (COMBI) to enable next-generation low-SWaP PIC-based imaging systems while overcoming the fabrication limitations of conventional refractive microlens arrays. Our technology is more flexible than conventional refractive microlens arrays, enabling custom co-design of the PIC and metalens array in tandem. Our solution will therefore enable high-performance low-SWaP imaging systems.

Warfighter Value: Applications such as star tracking will see reduced SWaP. Such a low-SWaP star tracker would enable additional payloads to be carried by the platform, enhancing the platform lethality.

WHEN

Contract Number: N64267-24-C-0010 **Ending on:** Aug 12, 2025

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Design review and coupling study completed	Low	Identification of metalens and grating co-design strategy with low insertion loss.	3	4th QTR FY24
Fabrication completed on initial prototype.	Medium	Wafer scale fabrication at high yield of several metalens array candidates.	3	1st QTR FY25
Optical metrology on prototype	Medium	Selection of optimal candidate design for mass-fabrication.	4	1st QTR FY25
Supply chain evaluation	Medium	Completed fabrication using alternative process to reduce risk associated with vendor capture.	4	1st QTR FY25
MILSPEC testing complete	High	Survival of metalens arrays under 833L conditions.	5	2nd QTR FY25
Updated fabrication	Low	Fabricate a new lot of arrays based on outcomes from metrology and MILSPEC testing.	5	3rd QTR FY25
Dicing/delivery of arrays	Medium	>90% yield of metalenses on spec.	5	4th QTR FY25

HOW

Projected Business Model: PSI is positioning itself as a vendor of customer metalens solutions for government and commercial clients. We intend to offer bespoke solutions for our customers' optical systems. The metalens arrays developed under this effort are part of a portfolio of technologies that can address multiple markets, but typically require customization to a particular need.

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

Potential Commercial Applications: Smartphone cameras and AR/VR represent a large potential application area for metalens arrays. The commercial market for cell phone cameras is substantially larger than the DoD market, with 3D cameras and associated optics for augmented reality and virtual reality (AR/VR) worth upwards of ~$1B and projected to grow more than five-fold by 2025. The thickness of the camera's optics are the primary driver of cell phone thickness – and there is premium value in being able to reduce the thickness of an optical system by even 25% using flat optics.

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