



CASCADE 2027 NON-CONFIDENTIAL SUMMARY »

Freeform Direct-Write and Rewritable Photonic Integrated Circuits

Overview

Photonic integrated circuits (PICs) play a significant role in computing, communications, sensing, and quantum technologies. Most PICs are currently fabricated using cleanroom based processes such as lithography and etching, which require specialized facilities, high capital investment, and lengthy development cycles. This technology enables photonic integrated circuits (PICs) to be directly written, erased, and rewritten in two and three dimensions on a low-loss phase-change material (PCM) thin film, allowing rapid prototyping and reconfiguration without conventional semiconductor fabrication processes. Applications include rapid prototyping, defense and intelligence applications, optical circuit switches, and education in photonics circuit design.

Description

This technology provides a platform for direct-write and rewritable photonic integrated circuits (PICs) by utilizing a thin layer of phase-change material (PCM), which exhibits distinct optical properties that change when exposed to controlled laser light. Utilizing direct laser writing (DLW), a focused laser beam induces phase transitions within the PCM to create optical circuits, entirely bypassing the need for traditional lithography and etching processes. Because this phase transition is fully reversible, specific regions can be erased and redrawn, allowing for multiple design iterations on a single chip. This capability enables rapid prototyping, testing, and iteration of photonic designs with significantly reduced time and cost. Additionally, these circuits can be written in two and three dimensions, increasing the density of PICs in a limited footprint.

Technology Readiness Level (TRL)

TRL 4 — System or subsystem components tested in a laboratory environment.

Value Proposition

- Rapid prototyping and signal processing have implications for high speed iteration of device designs and signals intelligence.
- Circuits can be erased and rewritten repeatedly, enabling reuse of the same device for multiple designs and applications.
- Programmable photonic systems for optical circuit switching and routing.

COMOTION REFERENCE »

BDP 8875

INNOVATION MANAGER »

Forest Bohrer

SECTOR »

Hardware

LEAD INVESTIGATOR »

Mo Li, PhD, Electrical and Computer Engineering and Physics, University of Washington

UNIVERSITY OF WASHINGTON

COMOTION »

1100 NE Campus Parkway, # 200

Seattle, WA 98195

Tel: (206) 543-3970

uwcomotion@uw.edu

comotion.uw.edu

Intellectual Property Position

[WO2025038213A3](#) – Patent application pending.

Market Opportunity

- The North American market for PICs is projected to reach \$9.9 billion by 2029, with optical communications making up nearly 60% of the total.
- Increased use of optical data transfer in computing and internet connectivity make photonics design and development a key technology need, particularly with the rapid development of AI technologies.

References

1. Wu, C.; Deng, H.; Huang, Y-S.; Yu, H.; Takeuchi, I.; Ocampo, C. A. R.; Li, M. "Freeform direct-write and rewritable photonic integrated circuits in phase-change thin films." Science Advances, 2024, 10, eadk1361. URL: <https://www.science.org/doi/epdf/10.1126/sciadv.adk1361>
2. Changming Wu, Ziyu Jiao, Haoqin Deng, Yi-Siou Huang, Heshan Yu, Ichiro Takeuchi, Carlos A Ríos Ocampo, Mo Li, "Reconfigurable inverse designed phase-change photonics," APL Photonics 10, 016113 (2025) URL: <https://doi.org/10.1063/5.0234637>