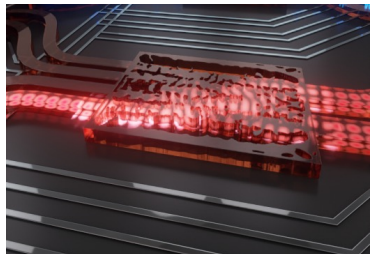
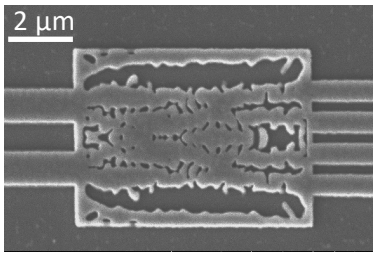
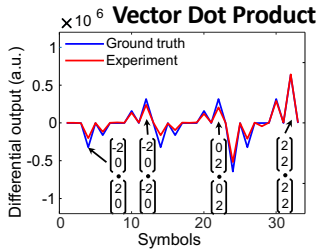
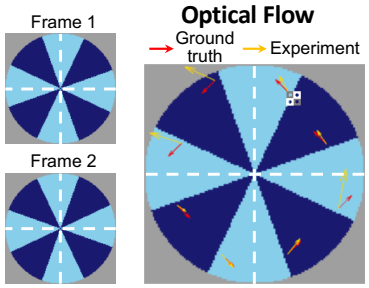
Ultracompact Mode-Multiplexed Vector Dot-Product Photonic Core









Schematic and scanning electron micrograph of the fabricated photonic computing core are shown on left. Experimental data of dot-product calculations of a sequence of 2-element vectors and optical flow calculation between two adjacent frames of a spinning wheel animation are shown on the right.

Scientific Achievement

We demonstrate a silicon photonics-based ultracompact photonic computing core that calculates vector dot products using mode division multiplexing.

Significance and Impact

Our computing core has ultralow latency, low power consumption, and integrates the functionalities of two-mode multiplexers and one multimode coherent mixer within a nominal footprint of 5x3 microns resulting in 100x smaller footprint compared to conventional devices.

Research Details

- The approach uses topology optimization-based inverse design to design the photonic computing core.
- The photonic computing core can perform multiple computing operations including complex number multiplication and motion estimation using optical flow.

This work was performed in part at the Center for Integrated Nanotechnologies.

Zhu, Z.; Sarma, R.; Smith-Dryden, S.; Li, G.; Pang, S. S. "Mode-Multiplexed Photonic Integrated Vector Dot-Product Core from Inverse Design." *Photonics Research* **2024**, *12* (10), 2279.