A new publication from *Opto-Electronic Advances* discusses low-loss chip-scale programmable silicon photonic processors.

Integrated optical signal processors have been identified as a powerful engine for optical processing of optical signals. They enable wideband and stable signal processing operations on miniaturized chips with ultimate control precision. Currently, there is a significant interest in providing functional reconfigurability, to match a key advantage of programmable microelectronic processors.

To implement large-scale programmable PICs with a large number of tuning elements, the challenge is to lower the loss of silicon photonic waveguides and minimize the random phase errors caused by the fabrication imperfection for the phase-shifters of those tuning elements.

The authors of this article propose a high-performance programmable silicon photonic processor by introducing low-loss multimode photonic waveguide spirals and low-random-phase-error Mach-Zehnder switches. These waveguide spirals are designed to be as wide as 2 µm, enabling an ultralow propagation loss of 0.28 dB/cm, which is much smaller than the traditional silicon waveguide (2-3 dB/cm).
Principle of arbitrary filtering operation (Input from port I4, and output from port O3). Measurements of filter spectral responses: (b)-(d) demonstrations of the FSR tunability for the filter; (e) demonstrations of passband shaping for the filter. Credit: Compuscript Ltd

Meanwhile, these MZCs and MZSs are designed with 2-µm-wide arm waveguides, and thus the random phase errors in the MZC/MZS arms are negligible, in which case the **calibration** for these MZSs/MZCs becomes easy and furthermore the **power consumption** for compensating the phase errors can be reduced greatly. In addition, each channel has a Ge/Si photodetectors and grating coupler to detect the signal.

By programming the device, this programmable silicon photonic **processor** is demonstrated successfully to verify a number of distinctively different functionalities, including tunable time-delay, microwave photonic beamforming, arbitrary optical signal filtering, and arbitrary waveform generation.


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