SiN PICs and PPICs for Photonic Neural Networks, High-Speed Transmitters, and Sensors

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Silicon Nitride (SiN) has emerged over the past years as the prominent material for fabricating Photonic Integrated Circuits (PICs), offering key advantages such as low cost, low propagation loss and improved coupling to single-mode fibers. A key strength of SiN lies though in its versatility to co-integrate various materials on the same chip enabling tailored properties for specific functionalities.
In this context, a SiN platform co-integrated with $BaTiO_3$ (BTO) demonstrated the capability to deliver ultra-efficient Phase Shifters (PSs), achieving a measured efficiency of 2.52 V·mm with a corresponding Pockels coefficient reaching up to 783 pm/V [1], while the propagation losses for the hybrid PSs were measured at 0.54 dB/mm. For a Mach–Zehnder Interferometer (MZI) employing these PSs, the power consumption during switching from ON to OFF states was found to be as low as 120 nW, delivering an extinction ratio between ON and OFF states up to 20 dB, with rise/fall times as low as 20 ns, limited by the electrical driving circuitry. These results establish the BTO/SiN platform as a compelling solution for large-scale photonic neural networks weighting a large number of input signals at ultra fast speed.
For high-speed transmitter applications, SiN contrary to silicon, is inherent incompatible with high-speed modulation. By co-integrating BTO and confining the optical field within ultra-dense slot waveguides using CMOS plasmonics, it is feasible to fabricate extremely compact modulator arrays capable of operating beyond 100 Gbaud, compatible with co-packaged optics. By altering the modulator configuration from simple MZM to Mach Zehnder In a Ring (MZIR) it is possible to reduce also the required voltage by 30% for Cu based plasmonics, while maintaining >100 Gbaud performance [2]. Experimental validation demonstrated 92 Gbps operation with a 3.5 Vpp driving voltage and only 10 μm-long plasmonic PSs in a MZIR device.
Plasmonics also enable high-sensitivity sensing by leveraging the strong interaction between the surrounding medium and surface plasmons propagating along the waveguide. A novel bimodal interferometer layout, achieved by folding the interferometer arms on a top and bottom propagating modes, demonstrated record-breaking sensitivities of up to 11,000 nm/RIU, setting a new benchmark for Plasmonic-Photonic Integrated Circuits (PPICs) in both performance and footprint [3].

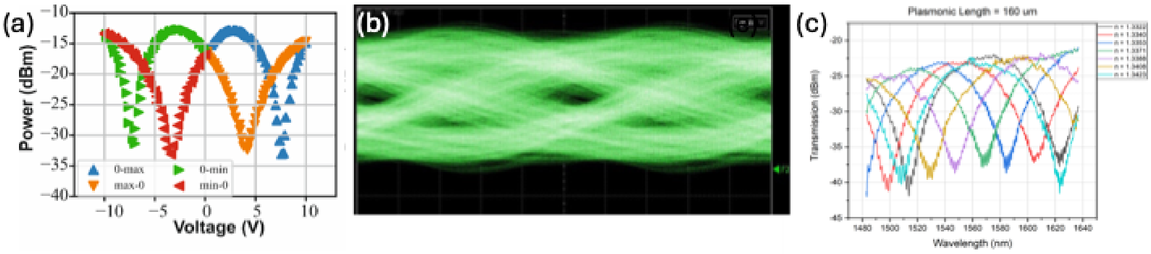

Figure 1. (a) Response of MZM with BTO PS featuring 2.52Vmm efficiency, (b) Eye diagrm of MZIR with BTO plasmonic phase shifters at 92Gbps, (c) Response of plasmonic Bimodal interfereomter with 11K nm/RIU sensitivity under different surrounding water based solutions.

REFERENCES
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