

Photonic Integration for Optical Interconnect and Sensing Applications

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Abstract—We will report design examples of PICs for applications in AI optical interconnect and optical sensing. The emphasis is on the development of high-power and tunable light sources based on InP platform and silicon passive and active components for WDM optical transceiver optical engine, photonic switching, and optical phased arrays.

Keywords—AI optical interconnect; optical sensing; silicon photonics, photonic integration, heterogeneous integration.

I. INTRODUCTION

Photonic integration circuits (PICs) are the disruptive technologies that will alter the competitiveness of various high-tech products and enable new applications. InP based PICs have been under intensive research for more than 30 years and found various applications optical networking. Silicon photonics (SiPh) platform is attractive due to its compatible with the fabrication process of mature CMOS integration circuits and also because of its high-contrast refractive indices, which leading to very compact waveguide and small bending radius. The applications as optical interconnects in AI data centers are the major driving forces to fertilize the eco-systems for the design, manufacturing, packaging, and testing of PICs.

Our recent efforts on applying PICs developed with Si/InP semiconductor foundry services to applications in optical interconnects for AI/HPC and optical sensing will be reported. For optical interconnect, high-power DFB lasers, silicon photonics multiplexer/demultiplexers (MUX/DeMUX) and WDM transceivers. For optical sensing, tunable lasers and optical phase arrays are developed. The ongoing project on developing 6.4/12.8-Tb/s Co-packaged optical transceivers and switched will also be discussed. The co-development of EIC for control, driving and detection of optical signals will also be reported. To compensate the loss on PIC, we are also collaborating with Czech Technical University to develop integrated waveguide optical amplifiers.

II. PIC FOR AI OPTICAL INTERCONNECT

The goal is to develop mass-producible photonic engine for optical interconnect and photonic switching in AI data centers for applications in the scale-up and scale-out domains. Therefore, we develop all the photonics chips using foundry-based manufacturing so the time to market can be greatly

reduced. We have developed high-power lasers for feeding multiple silicon modulators by using a novel multi-segment partial-grating DFB lasers that can achieve >250-mW of output power with narrow linewidth and low noise. We have realized high-performance MUX/DeMUXs and wavelength routers based SiN platform and 4-channel micro-ring modulator based WDM transceivers that can achieve 200Gb/s modulation per channel using silicon-on-insulator (SOI) platform.

III. PIC FOR OPTICAL SENSING

A 64-channel all-solid-state optical phase arrays (OPAs) with low divergent angle and large peak-to-sidelobe ratio are demonstrated. Our focuses are on optimizing grating antenna design for uniform emission, along with implementing phase compensation mechanisms to minimize the speckles resulting from fabrication induced phase fluctuations. Our results demonstrate that the proposed design achieves a uniform emission profile. A novel group phase compensation (GPC) methodology is introduced for rapid phase calibration, facilitated by a custom control interface and an in-house optimization algorithm. The 16x64 OPA with optical switching are also realized to reduce the required wavelength tuning range for achieving wide steering angle.

IV. CONCLUSION

Due to the mature of foundry-based fabrication services and fast-progressing heterogeneous integration and packaging techniques for PICs, the applications are booming. Fast growth of the market can be expected and collaboration is required to resolve all the technology challenges.

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