Demonstration of optical via and low-loss optical crossing for vertical integration of silicon photonic circuit

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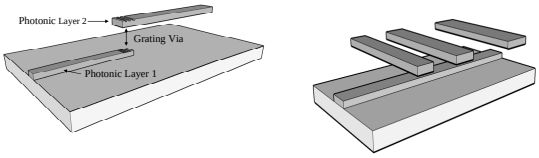
Abstract: We demonstrate optical via and ultralow-loss optical crossing in dual layer silicon photonic circuit. We have achieved crossing loss as low as 0.013± 0.0024 dB/crossing. By employing shallow etched grating couplers we couple light from one photonic layer to other with a coupling efficiency of 11%.

1. Introduction

With ever increasing complexity and density of photonic integrated circuits, the need for multilayer functionality is arising for next generation photonic circuitry. The vertically integrated circuit layers must be sufficiently isolated, at the same time, we should be able to transport optical signal from one layer to the other. In electronic IC's vertical integration can be easily realizable thought connecting different layers though a low resistant metal line. However, such routing in optical integrated circuits is not straightforward [1] .

In this paper, we demonstrate a CMOS compatible 1D grating assisted optical via and ultralow-loss waveguide crossing in a dual layer silicon photonic circuit.

2. Dual layer circuit



(a) (b)

Fig.1 Schematic of (a) waveguide crossing and (b) optical via in a dual layer circuit

We present two type of dual layer structure: Optical Via (Fig. 1a) and waveguide crossings (Fig. 1b). The devices were fabricated using layered CMOS approach. First photonic layer was fabricated on a crystalline SOI wafer [2] and second on low-loss (3.5dB/cm) amorphous Si [3]. The two photonic layers were isolated by 940nm of silicon dioxide. Fig. 2 depicts the cross-section image of a fabricated grating via. The process temperatures were kept below 400^{o}C to make the process CMOS back-end compatible for above-IC CMOS-Photonics integration.

The fabricated devices were optically characterized through transmission measurement. As a proof of concept, with a simple design for a grating assisted optical via, we have achieved a coupling efficiency of 11%. In case of optical crossing a loss of only 0.013dB is achieved per crossing.

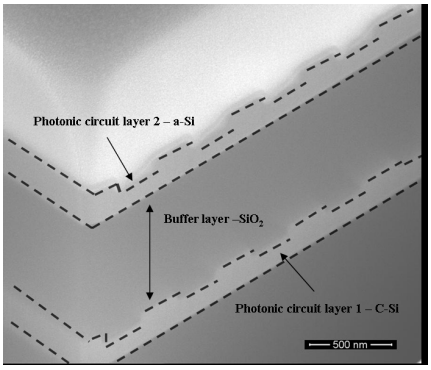


Fig.2 SEM Cross-section view showing the grating coupler in the bottom and top photonic circuit.

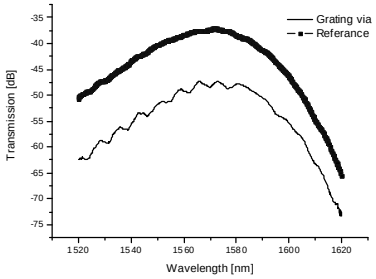


Fig. 3 Transmission spectrum of a grating optical via

3. Summary

Though this paper we demonstrate an optical via with a coupling efficiency of 11% and a loss of 0.013dB/crossing for waveguide guide crossing in a dual layer silicon photonic circuit.

4. Reference

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