Integrated Photonic Circuit for Spectral Testing and Fiber Alignment

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Introduction

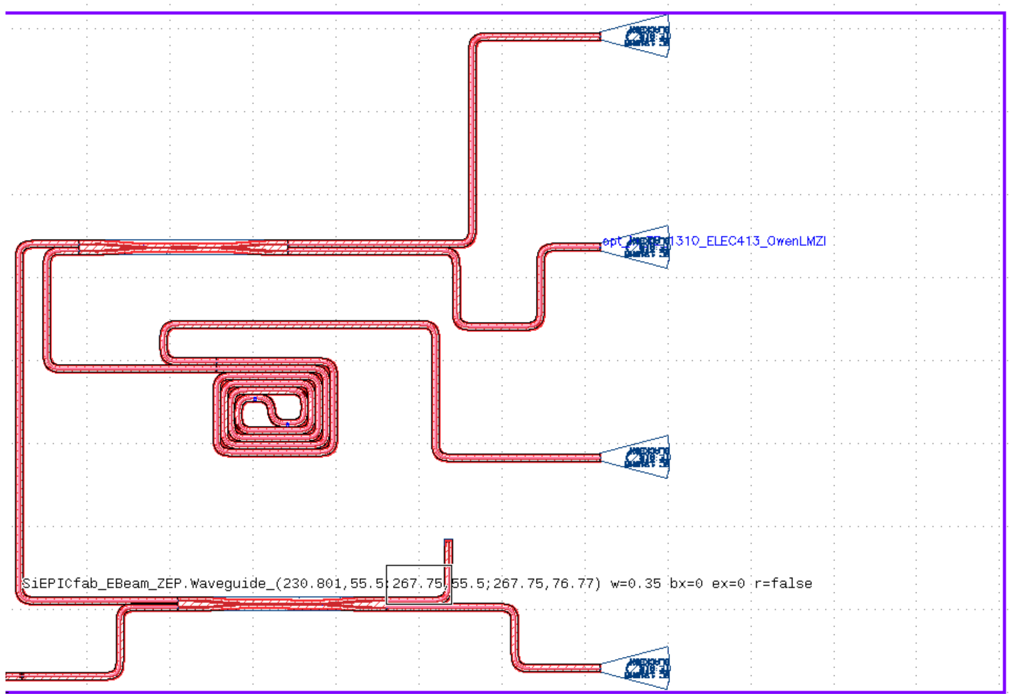
The purpose of this design is to develop and analyze an integrated photonic circuit featuring a **strip waveguide** with an input waveguide from a laser source and up to **three output fiber grating couplers** for optical signal extraction. This chip is intended for **fiber array alignment and optical transmission spectrum characterization**, with applications in **on-chip laser testing and spectral analysis**. The primary goal is to optimize the **waveguide geometry, Y-splitters, and grating couplers** to ensure efficient light propagation and minimal loss.

Theory

The strip waveguide in Chip #2 is designed with a 350 nm width and SiO_2 cladding to efficiently confine light and minimize losses, balancing mode confinement and propagation efficiency. The Y-splitter divides the optical signal with a balanced power split, ensuring minimal excess loss and phase coherence for a 25 GHz channel spacing. Grating couplers are employed for coupling light between the waveguide and optical fibers, with the grating period and etch depth optimized for efficient fiber-to-chip coupling. The spectral testing approach utilizes a tunable laser source for swept wavelength analysis, characterizing the chip's response to different wavelengths. On-chip laser integration and a swept current source facilitate detailed spectral testing and allow the evaluation of how varying electrical conditions impact performance. Fabrication considerations include careful management of etch depth, waveguide dimensioning, and mask alignment to ensure optimal mode confinement, minimize light leakage, and ensure accurate alignment with the fiber array, thus preventing phase mismatch and loss.

Modeling

The **waveguide design** features a strip waveguide with a silicon core of 350 nm width, surrounded by SiO_2 cladding, which serves as the primary guiding layer and surrounding medium. The etch depth is carefully considered, with trench width adjustments made to optimize modal confinement. The input position is set at (0, 10 µm), and the routing is designed to minimize bends and propagation losses for efficient signal transmission. The **Y-splitter** is implemented to split the incoming optical signal into two arms, with careful design considerations to ensure a balanced splitting ratio, minimize excess loss, and maintain phase coherence, crucial for the 25 GHz channel spacing. **Grating couplers** are used to couple light between the waveguides and external fibers, with a testing setup that includes GC #2 as the laser input for fiber array alignment, GC #1 and GC #3 as power detectors for alignment verification, and GC #4 providing an additional optical output for further analysis.The delta L is determined to be around 2.5 mm.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