Fiber-Waveguide Coupling for HIC

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Integrated optical circuit designs seek to incorporate several optical functions on a single semiconductor chip. However, there is a need to couple signals from optical fibers to the on-chip waveguides and vice versa. Direct coupling results in high power-loss from three sources: reflections due to the difference in refractive index of the core materials, a mode-size mismatch between fiber and waveguide, and a mode-shape mismatch between a fiber’s circular and waveguide’s elliptical mode fields.

In this work, we explore an on-chip coupler to transform light from a single-mode optical fiber to a single-mode waveguide fabricated entirely by CMOS-compatible processes in MTL. In the vertical direction, the fiber mode diameter is reduced by a stack of varying refractive index layers formed on a cladding layer [1]. The layers, silicon oxynitride deposited by plasma enhanced chemical vapor deposition (PECVD), gradually increase in refractive index from top to the lower waveguide layer on oxide cladding on a silicon substrate. The lateral mode field conversion is completed with a linear taper and lens at the input facet [1, 2]. Both the lens and the tapered shape of the stack are defined through plasma etching.

The efficiency of the above fiber-to-waveguide coupling scheme has been measured and plotted as function of coupler length, input lens radius, and widths of input and output facets. The results are to supplement and correct the theoretical simulations of such structures with beam propagation (BPM) and finite-difference, time-domain (FDTD) methods.

REFERENCES: