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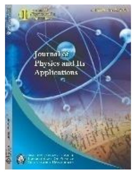

Coupling Efficiency of A Spot Size Converter For Optical Fiber-Chip Connections

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ABSTRACT

The light propagation in optical waveguide must be able to maintain low propagation loss, low coupling loss and scattering loss condition, especially in the junction. In this research, a spot size converter is proposed to preserve the lowest coupling loss. This optical converter is composed of a single mode optical fiber (SiO_2) including inversed taper. The optical input signal from the optical fiber is launched into photonic integrated circuits and then coupled into the Si-Slab waveguide. Furthermore, linear form with the length dependence has been studied to obtain the optimal position of optical fiber and the chip and analyzed the coupling efficiency of it. The purpose of this research is to procure the optimal form of spot size converter. The simulation result shows the coupling loss of linear form is 0.62 dB and 0.24 dB on TE and TM mode condition respectively. Along with the increase in the taper length, the coupling loss obtained tends to decrease as well. So that, it can be assumed the design of a linear form with 100 µm taper length provides the highest coupling efficiency.

1. Introduction

Nowadays, internet services such as mobile application, video streaming, e-commerce, and social media have become a part of daily life. Consequently, it will result in the massive growth of data exchanged over networks which makes modern telecommunications require significant technological advancement. Moreover, one of the most important things on telecommunications is optical waveguide. Advancements in optical technology have already revolutionized the communications field, allowing for modern high-bandwidth trans-oceanic transmission through optical fibers [1].

There are so many cases where a communication system requires various optical waveguide. One of the most important things in the simultaneous usage of various optical waveguide is the coupling connections. We have to pay much attention to reduce the coupling losses caused by the mismatch of optical waveguides used in the system. The coupling loss is a dominant factor compared to another type of losses [2]. Therefore, introducing a spot size converter (SSC) in the end facet of the optical waveguide is an effective way to reduce the coupling loss. A common approach in the edge coupling is the usage of an inversed taper. The light from the optical fiber is coupled to a narrow waveguide tip which can expand the mode field size [3], [4].

Most SSC solutions deployed in the field are constructed with the same material as the optical fibers, which is SiO_2. Etching is one of the most common methods used in SSC development. Since photonics mode expansion needs lateral and vertical dimension tapering as well for a universal SSC design, it should give the designers a flexibility to control the SSC size for different edge coupled components. Although, silicon waveguide can now be considered as a proven technology, its compatibility with optical fiber components is still relatively limited, mainly due to the large size mismatch between the optical fibers and silicon waveguide modal distributions. Because of this, coupling method to and from silicon waveguide components with large efficiencies is still a relevant challenge [5].

Besides, various coupling techniques are currently being explored, including grating coupling [6] and end-firing from macroscopic fibers [7], where coupling efficiencies up to 70%–80% to on-chip waveguides have been achieved. More recently, on-chip silicon waveguides have been coupled to the waist of a biconical fiber taper [8] with an efficiency over 93%.