Large Cross-Section Rib Silicon-On-Insulator (SOI) S-Bend Waveguide

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Large cross-section rib silicon-on-insulator (SOI) S-bend waveguide

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ABSTRACT

S-bend SOI waveguide is known as the most critical part for SOI device design. Normalized output power for the different parameter of the S-bend waveguide has been analyzed using OptiBPM simulator in 1.55 μm communication wavelength. Dimension of 5 × 5 μm^2 single-mode rib waveguide is chosen. The variable parameters are transition offset and lateral offset, given the waveguide length of 100 μm–5000 μm. The maximum normalized output power achieved at the waveguide length of 550 μm for the 10 μm S-bend offset is 95.81%. Moreover, the ideal lateral offset is 2.7 μm with 2.52% normalized output power improvement.

1. Introduction

It is well known that the silicon-on-insulator (SOI) has an excellent platform which offers complete suite of photonic components with a broad range of optical devices. The fabrication process is commonly compatible with CMOS technology. Furthermore, SOI is transparent at the communication wavelengths such as 1.55 μm wavelength region and is suitable to integrate electric and optical devices on one chip. The high refractive index contrast in SOI waveguides allows for a high confinement of light enables highly integrated structure with ultra-sharp bending to be designed.

In current years, there have been many devices fabricated on SOI platform including passive and active devices like coupler/splitter [1], modulators, switches, filters, wavelength (de-)multiplexers, Raman laser/amplifiers, and detectors [2]. The basic structures of these devices are made of straight and bend waveguides. Therefore, the particular analyses on the basic structure have been given much attention at the beginning of the research toward the optimum device performance.

A bent waveguide is an important element for photonic integrated circuits (PICs). S-bend waveguide is one of the bend structures that can change the propagation direction by separating two or more output in the optical devices. S-bend SOI waveguide is very compatible in an integrated optical circuit due to the size of the waveguide smaller than other semiconductor. Generally, the bending loss increases when the bending radius of the S-bend decreases. Consequently, to reduce the bending loss, the bending radius has to be increased. This will make total size of the PIC becomes large, which is not suitable for realizing a high integration density. On the other hand, the large refractive index contrast in SOI can generate a small curvature radius with the low bending loss due to the strong mode confinement and reduce the total size of the PIC.

Research on bend waveguide has been performed since 1969 [3] with different approaches, methods and materials to create optimum result depending on the desired application. Several solutions are investigated to get the optimum result including improving the rib sidewall slope, offsetting the guides, placing isolation trenches [4], adding the spline bend between the straight and the bend [5] and combination of several techniques. The previous research on bend waveguide including 90°-bend [6,7], 60°-bend, cosine S-bend [8], spline bend, and hybrid bend [5]. Some researchers used multimode structure at the bend as the higher order mode will be more affected with the decreasing of bend radius compare to the fun-

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