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フォトニックワイヤーボンディングを用いた Si 光回路間の伝搬特性解析

Analysis of Transmission Characteristics between Si chips with Photonic Wire Bonding

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1 Introduction

In optical interconnects, connecting components based on heterogeneous materials such as Si- and III-V- photonic devices on separate chips is still challenging. The photonic wire bonding (PWB) [1], where 3-dimentional transparent polymer wires have been proposed to bridge a gap between different optical elements, is one of promising techniques.

For the PWB in optical interconnections, especially in the Si photonics, one of the most important parameter is the coupling efficiency between a Si wire waveguide and a polymer wire. In this paper, we analyzed transmission characteristics between these two elements.

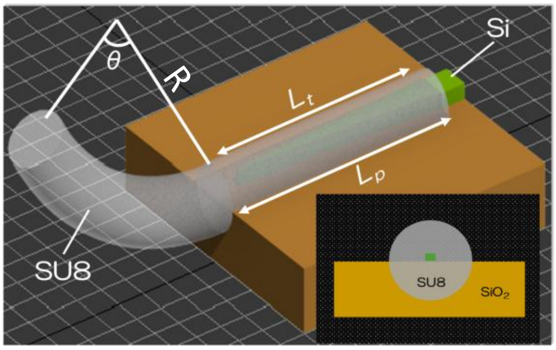

Fig. 1 Simulation model for calculating transmission efficiencies.

2 Simulation model and results

Our simulation model is shown in Fig. 1. The size of the Si wire waveguide was assumed to be 220-nm-thick and 500-nm-wide and located on a buried oxide layer. We used SU-8 (index of the material was set to be 1.57) as a polymer material (The nonlinear multiphoton absorption process arising from the irradiation by intense femtosecond laser pulses allows direct 3D-writing of photonic structures inside SU-8 [2]). In this simulation model, the Si wire waveguide was tapered down to a tip width w_{tip} over a length of L_t in the transition section and enclosed by the PWB with a length of L_p before bending so that reflection loss could be suppressed.

First, appropriate radius of a SU-8 wire to obtain single mode propagation was estimated. Fig. 2 shows mode characteristics as a function of radius of the SU-8 wire calculated using Finite Difference Method (FDM). Multi-mode propagation could be suppressed when the radius of the SU-8 wire is smaller than 750 nm.

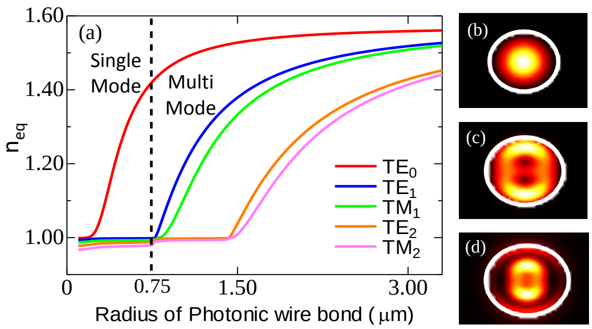

Fig. 2 (a) Mode characteristics as a function of radius of SU-8 wire calculated for 1.55 μm (b-d) distribution profile for each mode.

Next, finite-difference time-domain (FDTD) simulation was performed to analyze transmission characteristics between the Si waveguide and the SU-8 wire. Fig. 3 shows transmission loss of SU-8 wire as a function of radius of curvature R, calculated for several bend angle θ, where the radius of SU-8 wire was fixed to be 750 nm. The transmission loss would be suppressed along with the increase of the curvature R and negligible when the curvature is larger than 7 μm whatever the bending angle θ is.

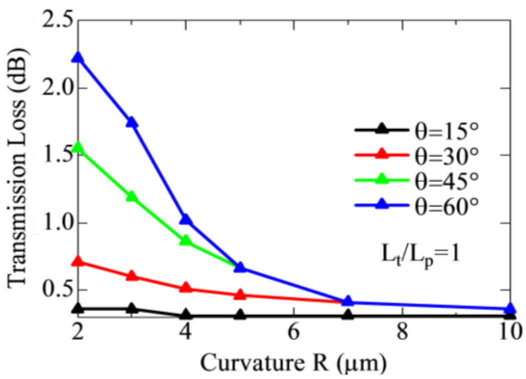

Fig. 3 Transmission loss as a function of bend angle θ curvature R of SU-8 wire is a parameter.

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References

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[2] N.Lindenmann, et al., *Proc. SPIE* 8613, (2013) W-1.