Control of Directional Coupling Based on Adiabatic Elimination

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The control of the coupling and the reduction of cross talk between densely packed waveguides will be of great importance to increase the integration density of silicon photonic chips. Here, we controlled the dark mode of the coupling in three-waveguide system based on adiabatic elimination (AE). The three-waveguide system was equivalent to the atomic three-level system, and the middle waveguide functioned as the intermediate dark state, which had no coupling with the outer waveguides[1]. The AE scheme was realized when the outer waveguides were identical and the propagation constant of the middle waveguide was larger than the other waveguides. This regime can be achieved in a four-waveguide system as well[2].

Figure 1 shows the demonstration of AE in silicon waveguides. The waveguides were made on an SOI wafer with a 340 nm-thick device layer. The gap between silicon waveguides was 210 nm. Figure 1 (a) illustrates three identical waveguides with widths of 220 nm. As shown in the images of the far field and the near-field scanning optical microscopy (NSOM), the coupling among three waveguides was observed. Figure 1 (b) shows the condition of AE, where the middle waveguide was wider (280 nm) and decoupled from the outer waveguides.

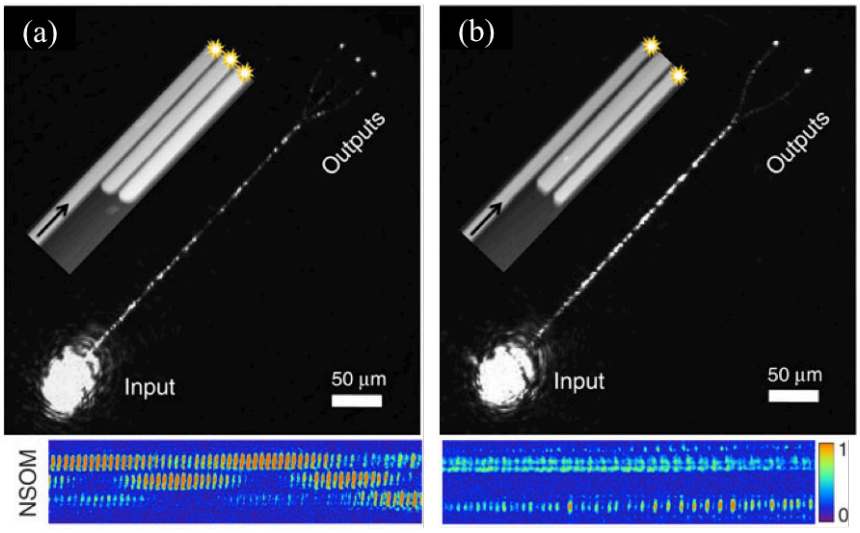

Fig. 1. Scanning electron microscope, far field, and near field images of directional coupling in densely packed silicon waveguides. (a) All waveguides were 220 nm wide. (b) AE regime, where only the middle waveguide was 280 nm wide.

References

1) T. Hatakeyama et al., Nature Comm. **6** (2015) 7565.

2) M. Mrejen, H. Suchowski, T. Hatakeyama, Y. Wang, and X. Zhang: Nano Lett. **15** (2015) 7383.