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マイクロリング共振器の作製誤差の無損傷検出方法

A non-damage method for the detection of the fabrication errors of microring resonators

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1. Introduction

Waveguide trimming, a post-process to adjust the on-resonance wavelength offset from the design of silicon photonic structure, is a necessary process since the errors incurred during the fabrication process is inevitable [1]. In prior to the waveguide trimming process, the detection of the error patterns is the key point. This report proposes a simple and non-damage approach based on photoluminescence (PL) spectrum analysis for the fabrication-error detection for silicon photonics.

2. Experiments

SOI wafers with a 220 nm top Si layer and a 3 μm buried oxide layer were used for the fabrication of the microring resonators. The silicon microring resonators with the radius of 5 μm and the waveguide width of 400 nm were designed and those patterns were defined by electron beam lithography system. A 5-micron SiO_2 over cladding was deposited at the top. The quasi-TE mode transmission spectra of the fabricated ring resonators were measured by using a tunable laser with a 20 pm scanning resolution. The PL spectra were obtained by a micro-PL measurement system.

3. Result and discussion

In order to examine the influence of the fabrication errors on the characteristics of the silicon microring resonators, the transmission spectra of two identical designed microring resonators were measured and Fig. 1 (a) and (b) give the typical results of the transmission spectra. The 5.1 nm offset of resonant wavelength can be observed at around 1535 nm, though the design of those two rings are identical. In general, if the chip is designed for facet coupling, to find out such error rings, the damage of the chip such as chip dicing is necessary, which may bring troubles. For our proposed solution, the on-line PL spectrum characterization can directly identify the error micorings without any damage. Fig. 1 (c) and (d) show the PL spectra of the two microring resonators mentioned above. The 3.0 nm offset of resonant wavelength can be observed from the PL spectra. This result indicates that the PL characterization is a convenient way for the fabrication error detection. Furthermore, it should be noted that based on the values of the PL on-resonance peaks, the peak offsets at C-band range can be estimated by extrapolating the PL data points. According to the result shown in Fig. 1, the resonant peak offset incurred by the fabrication error at C-band is 1.7 times of the one obtained by PL spectrum.

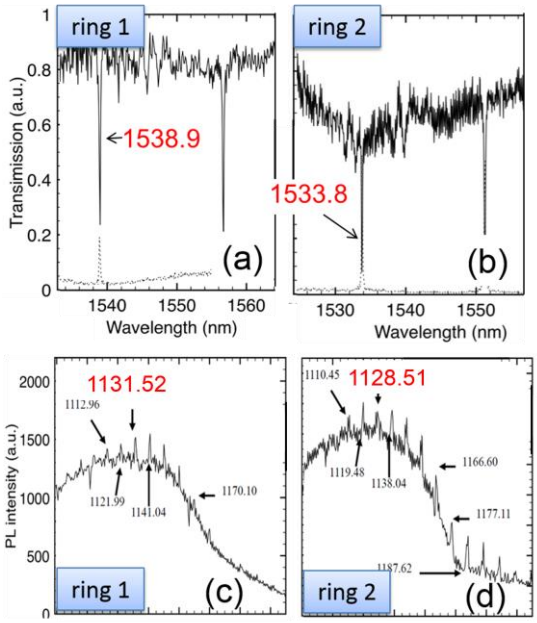

Fig. 1 Comparison of the transmission and PL spectra of two microring resonators. (a) the transmission spectrum of Ring 1; (b) the transmission spectrum of Ring 2; (c) the PL spectrum of the Ring 1; (d) the PL spectrum of Ring 2.

4. Conclusion

We have introduced a non-damage approach for the detection of fabrication error by using the PL characterization and demonstrated that this approach is promising for the fabrication error detection for the application of silicon photonics.

Reference:

[1] V. Raghunathan, *et al*, in Proc. Group IV Photonics, IEEE, 45-47 (2012).