

The Maximum Transmission Rate for the Racetrack Microcavity Resonator

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ABSTRACT

This paper determines the possibly maximum rate for the optical signal transmitting through the racetrack resonator devices. The method of finite-difference time-domain was employed to determine how an optical impulse getting through the device. We observe that the signal requires a certain number of round-trips to couple the signal to the throughput, and causes the delay of the pulse outputting from the device. This indicates that the possible pulse width is in a range of picosecond, which corresponding to the maximum transmission rate of over a hundred gigabits per second.

METHODOLOGY

The maximal transmission rate for an optical signals getting through the devices can be determined directly from the impulse response of the device. This could be done by a simple tracing the behavior of an optical pulse, which is launched at the entrance of into the device, getting through the device regarding with the electromagnetic field interaction based on Maxwell Equations. Here we employed the Finite-Difference Time Domain (FDTD) as the tools for simulating of the field interaction. The FDTD algorithm has been used for the analysis in the presence of perfectly matched layer absorbing boundary conditions [1]-[2].

The device structure used in the simulation are shown in Figure 1. The straight section is to consider the coupling between the guide and the racetrack. The racetrack microresonator with the cross section of $0.4\mu\text{m}\times 0.4\mu\text{m}$ provides the optimal coupling [3]. The device was set to have the straight sections of $3\mu\text{m}$ and the curved section with the curvature of $1\mu\text{m}$ for the simulation.

The FDTD was used for simulation of the output spectral coupling power from the device for a number of roundtrips. We observed that the output will get steadily coupled by roundtrips of more than ten. Further more, the signal response along the time was also observed as the signals in Figure 2. When an optical pulse was launched into the device, the output pulse would gradually develop its power to a maximum level. And at the end of the input pulse, the output pulse would exponential decay. It needs approximately 2.5ps for rising time to the maximum level, and 1.5ps for the falling time down to the zero level. Namely, the pulse requires the totally minimal time of 4 ps. Therefore, the device can transmit the maximal bit rate of 125Gb/s.

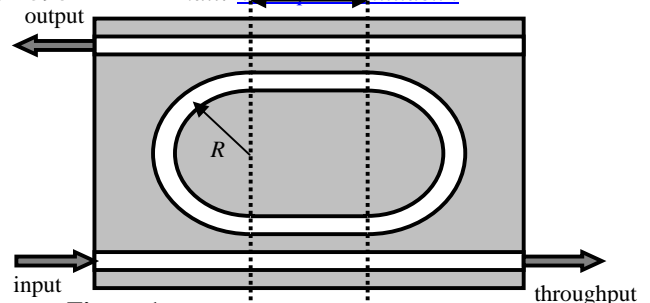


Figure 1. The structure of the racetrack resonator.

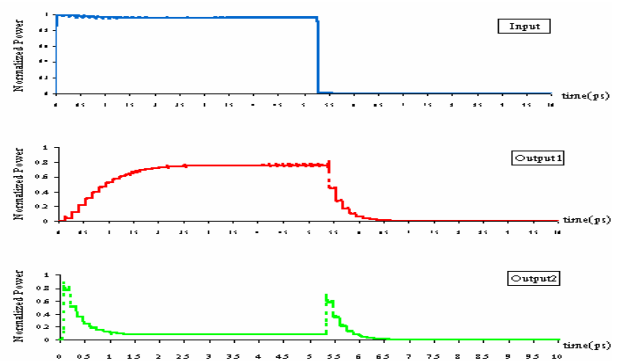


Figure 2. The optical pulse response through the racetrack.

CONCLUSIONS

The maximum rate of the racetrack resonator on silicon substrate has been determined using the finite difference time domain method. The numerical data were obtained in terms of the number of roundtrips that fulfill the energy settled in the racetrack, and the optical pulse response of the pulse getting through the device. From the results, the accumulation of energy accumulation causes the delay and decay of the output. Thus, the optical signal could have the minimum pulse at 4ps, corresponding to 125 Gb/s.

REFERENCES

- [1] K. S. Yee, "Numerical Solution of Initial Value Problems Involving Maxwell's Equation in Isotropic media", IEEE Trans. Antennas Propagat., vol. AP-14, pp. 302-307, May 1966
- [2] L. P. Berenger, "A perfectly Matched Layer for The Absorption of Electromagnetic Waves", J.Comput. Phys., vol. 114, pp. 185-200, Oct. 1994
- [3] W. Sutathammawat, S. Somkuarnpanit and K. Sae-Tung, "Design Silicon Based Race Track Resonators Using FDTD", Proc. of 2000 IEEE Asia-Pacific Microwave Conference, 3-6 Dec. 2000, Australia, pp.1183 to 1186.