Why Optical Interconnect? (1) Speed

\[ W = \frac{S}{2} \]

PD
LD
WAVEGUIDE
LD DRIVER
WAVEGUIDE
AMP.

Optical Interconnect

Outline of ULSI with Optical Interconnect

Optical switch using ring resonator

Compact size – only 10 μm order

Why Optical Interconnect? (2) Size

Optical Properties of Ring Resonators on Si Chips
Race-Track Resonator and Optical Switch using Electro-Optic Material

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Coupling efficiency is easily enhanced by changing $L$.

Resonance Wavelength $\lambda$

$$\lambda = \frac{2\pi R + 2L}{m}$$

$n_{\text{eff}}$ : Effective Index

$m = 1, 2, 3, \ldots$

Dips of Output 1 well correspond with Peaks of Output 2.

Observed resonance wavelength agrees with 2D FDTD* simulation.

FDTD = Finite Difference Time Domain

Experimental Results (1)

Cross Section of Silicon Nitride Core Waveguide

Silicon Nitride $n=1.785$

SiO$_2$ $n=1.46$

Si Substrate

Deposited by Plasma CVD

$W=3 \, \mu m$, $R=10 \, \mu m$, $g=0.2 \, \mu m$

$L=12.56 \, \mu m$

$W_{\text{Cross Section}} = 0.8 \, \mu m$

$1.6 \, \mu m$
Cross Section of BST Core Waveguide

Silicon Nitride  (1) to prevent diffusion of Ba, Sr, and Ti
(2) stopper for CMP* of BST

Si Substrate

BST  Made by Damascene Method

SiO₂

Experimental Results (2)
— Different Type Resonators —

Output Power of Type A is greater than Output Power of Type B

Same radius and circumference
Different coupling length $L$

$W=3 \ \mu m, \ R=10 \ \mu m, \ g=0.2 \ \mu m$
$L=12.56 \ \mu m \ (Type \ A)$
$L=6.28 \ \mu m \ (Type \ B)$

Measurement Method of Electro-Optic Coefficient

Interference pattern changed between $V=0$ and $V \neq 0$

$V$

BST (sputter deposited)
Ir
P-Si

P-Si

II. Electro-Optic Material
— (Ba,Sr)TiO₃ (BST) Film —

700 nm thick film was spin coated as follows

Spin-coating of 60nm thick film
Heating at 150°C

12 Times

After that, Heating at 700°C

$O_2$
Conclusion

1. Race-track ring resonator is successfully fabricated and its characteristics are measured.
2. Optical switch using tunable optical ring resonator is proposed.
3. Electro-optic material (Ba,Sr)TiO$_3$ is developed and its electro-optic coefficient is measured.

Future Plan

- To realize tunable ring resonator using BST core and measure its characteristics.
- Improvement of resonance characteristics.