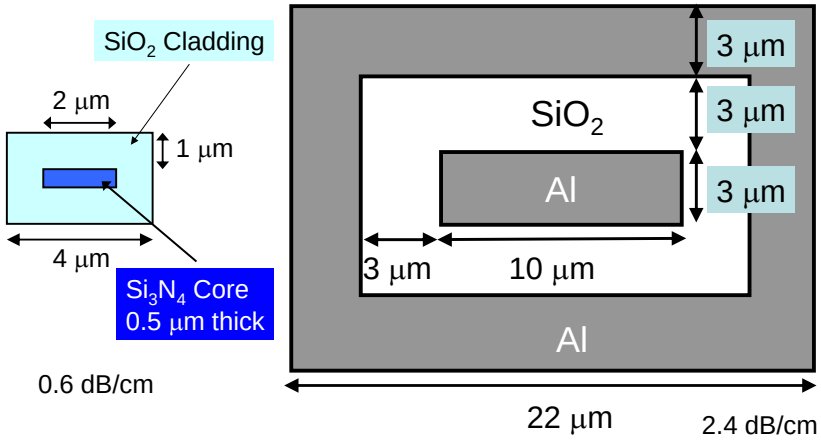
# Why Optical Interconnect? (2) Size




(a) Optical Waveguide (b) Coaxial Transmission Line

# Optical Properties of Ring Resonators on Si Chips

## Race-Track Resonator and Optical Switch using Electro-Optic Material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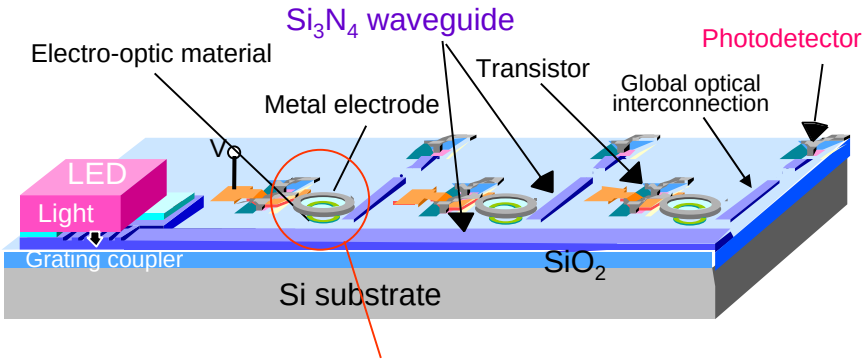
Keita Wakushima, and Shin Yokoyama

Research Center for Nanodevices and Systems
Hiroshima University

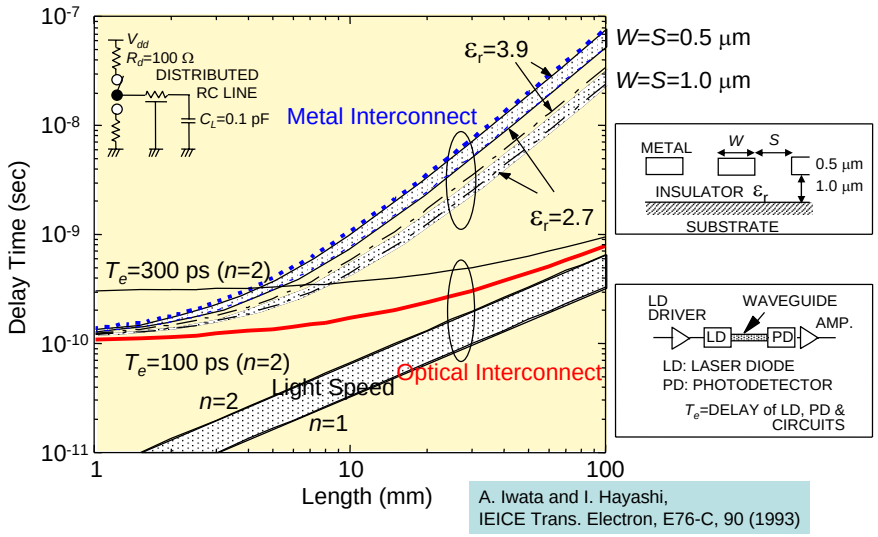

# Outline of ULSI with Optical Interconnect




Optical switch using ring resonator

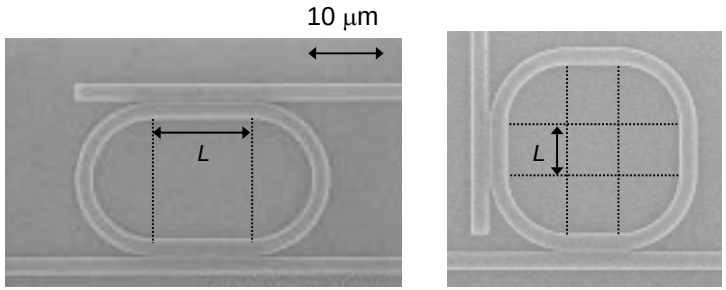
Compact size – only 10 μm order

# Why Optical Interconnect? (1) Speed




A. Iwata and I. Hayashi,
IEICE Trans. Electron, E76-C, 90 (1993)

# SEM Images of Fabricated Resonators

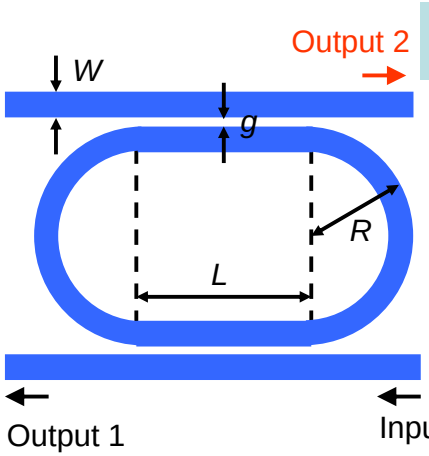



Type A — Race-Track

Type B — Square with Round Corner

*L*: selected for the same circumference

# I. Race-Track Resonator




Light with resonance wavelength goes to Output 2

Resonance Wavelength $\lambda$

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

$n_{eff}$ : Effective Index

$m = 1,2,3,...$

Coupling efficiency is easily enhanced by changing *L*

# Experimental Results (1)

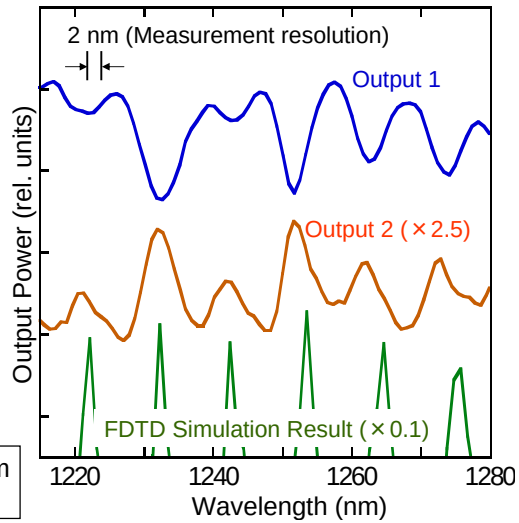
## — Output Power of Race-Track Resonator —

Dips of Output 1 well correspond with Peaks of Output 2

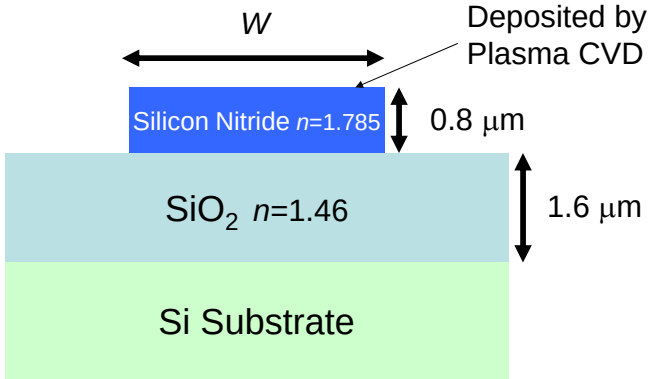
Observed resonance wavelength agrees with 2D FDTD* simulation

FDTD = Finite Difference Time Domain

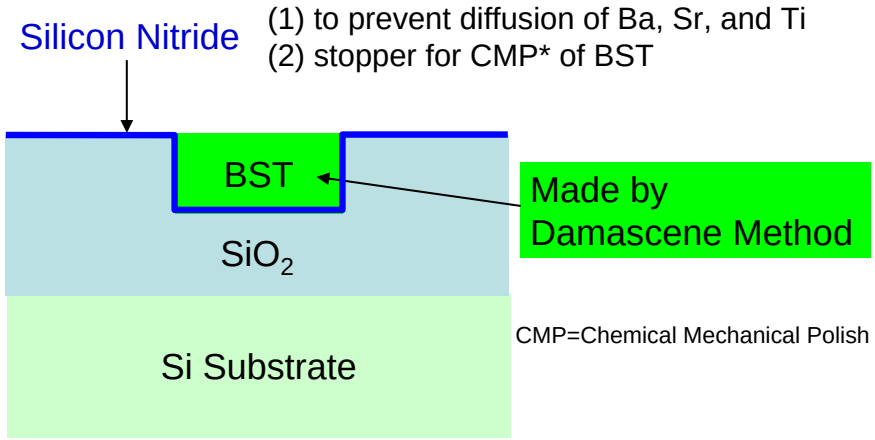
*W*=3 μm, *R*=10 μm, *g*=0.2 μm
*L*=12.56 μm




# Cross Section of Silicon Nitride Core Waveguide



# Cross Section of BST Core Waveguide




# Experimental Results (2)

## — Different Type Resonators —

Same radius and circumference

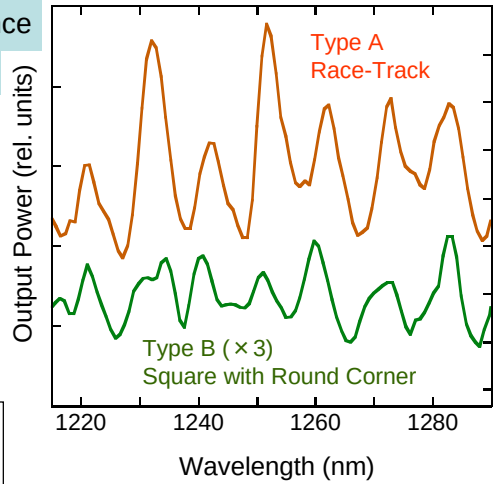
Different coupling length *L*

Output Power of Type A

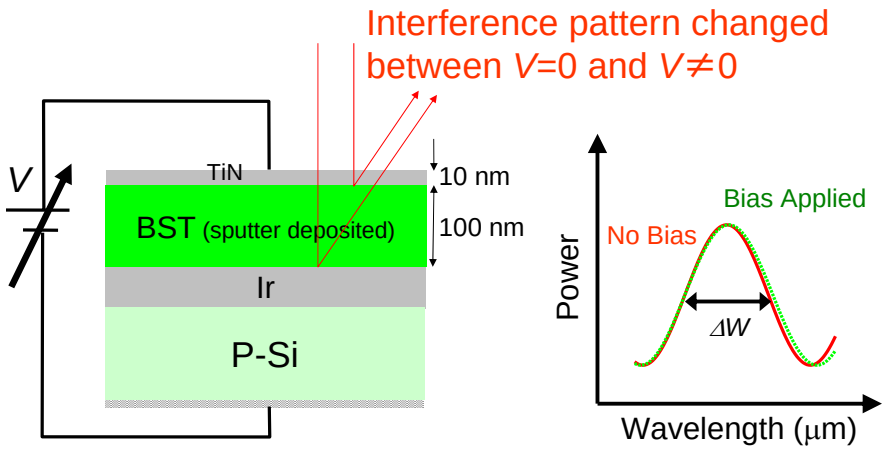
is greater than

Output Power of Type B

*W*=3 μm, *R*=10 μm, *g*=0.2 μm
*L*=12.56 μm (Type A)
*L*=6.28 μm (Type B)



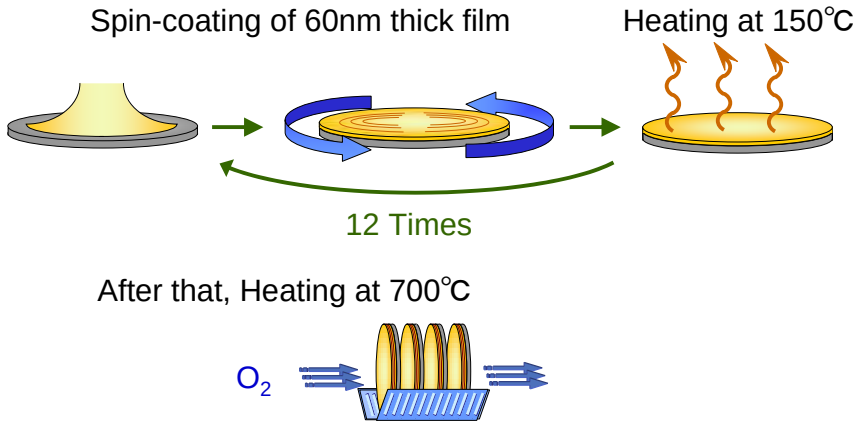

# Measurement Method of Electro-Optic Coefficient




# II. Electro-Optic Material

## — $(Ba,Sr)TiO_3$ (BST) Film —

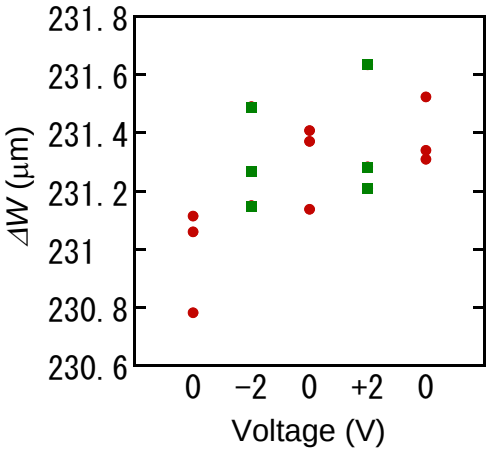
700 nm thick film was spin coated as follows



# 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.

# Electro-Optic Coefficient of BST



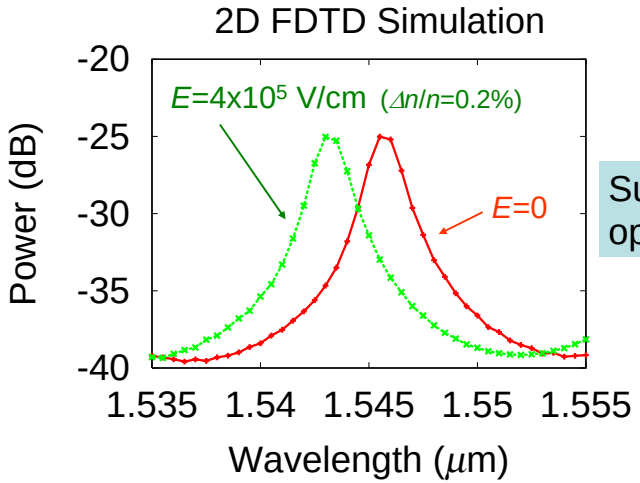

Index decreases about 0.1% under $2 \times 10^5$ V/cm

Similar to $BaTiO_3$

# Future Plan

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

# Optical Switch using Tunable Ring Resonator with BST Core




Sufficient for optical switch