

# **Silicon photonic devices and integrated circuits**

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# Contents

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## I. Applications

- I. Long-haul/metro coherent optical networks
- II. Optical interconnects for routers and switches
- III. Datacenters and supercomputers

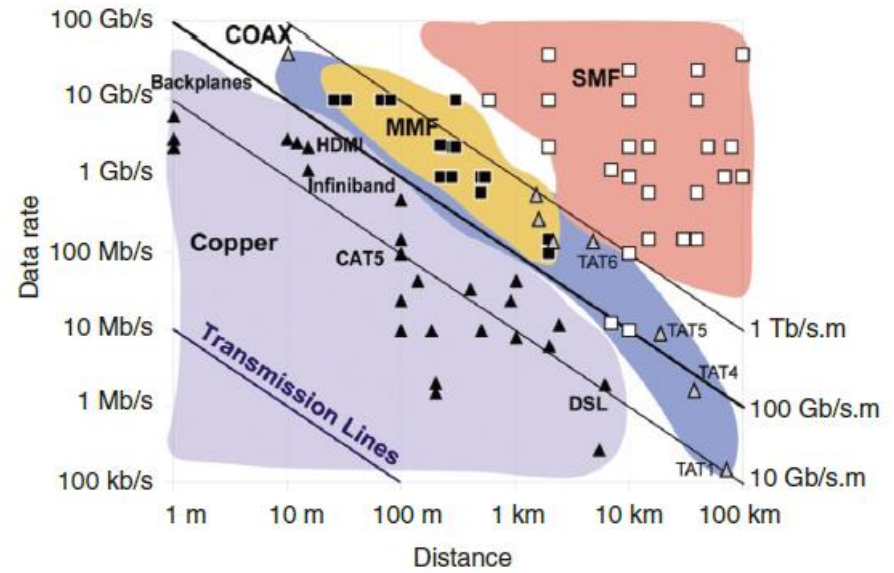
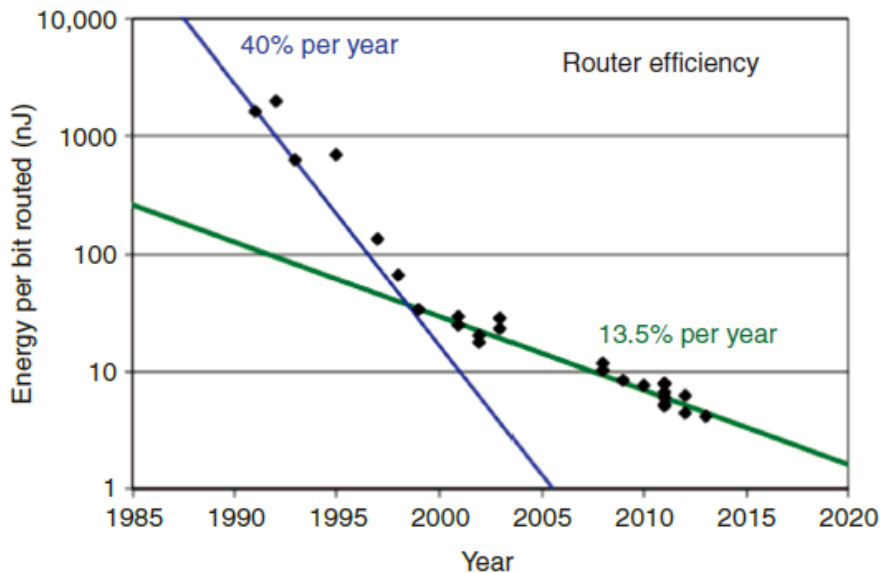
## II. Silicon Photonic devices

- I. Single-drive push-pull silicon MZMs
- II. Hybrid silicon/III-V lasers
- III. On-chip polarization elements

## III. Conclusions

# Applications

- Long-haul/metro coherent optical networks
- Optical interconnects for routers and switches
- Datacenters and supercomputers

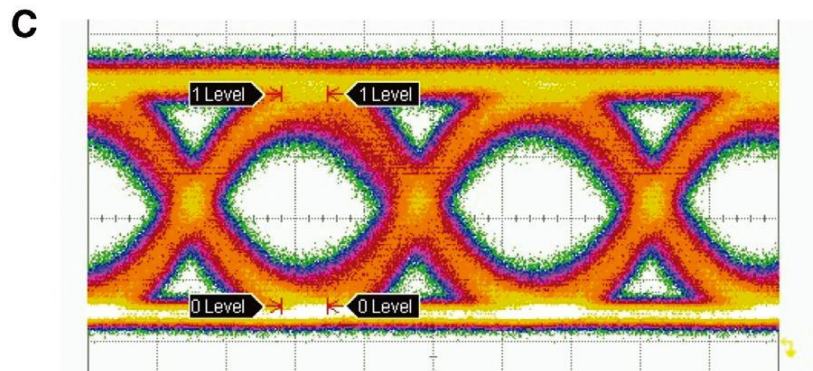
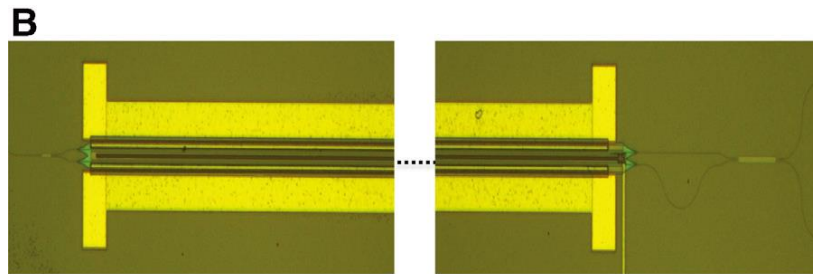
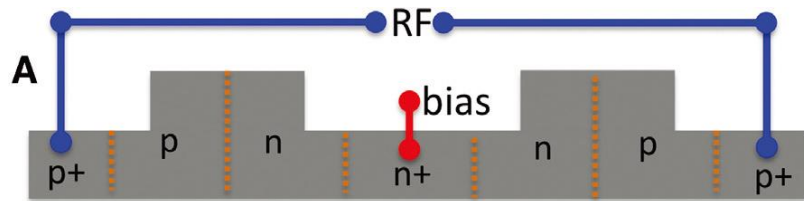


# Silicon Photonic devices

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- Single-drive push-pull silicon MZMs
- Hybrid silicon/III-V lasers
- On-chip polarization elements
  - SiN-assisted polarization rotators

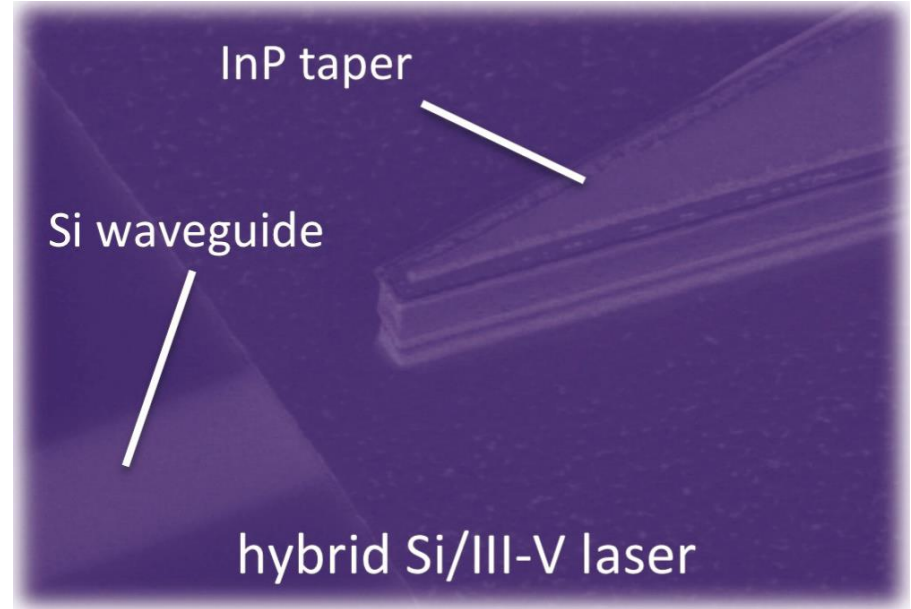
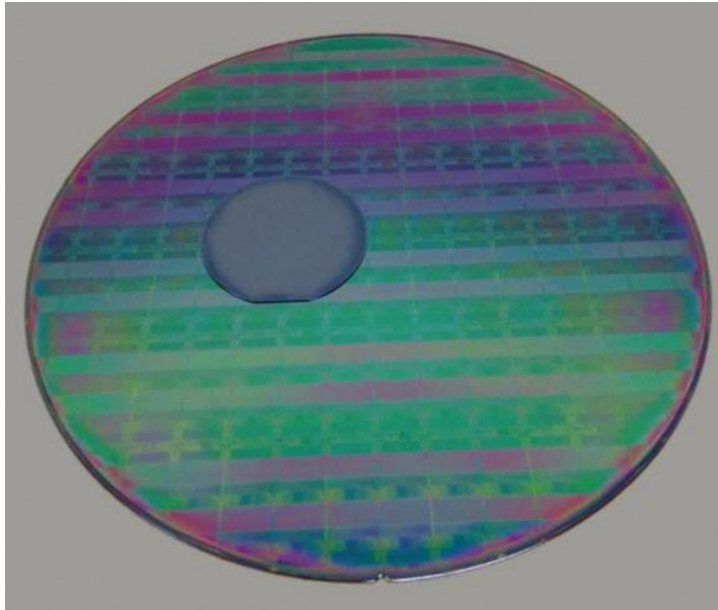
# Single-drive push-pull silicon MZMs



- MZM performance parameter
  - Bandwidth
  - $V_{pi}$
  - Insertion loss
  
- free-carrier induced index change
  
- Series configuration of junction capacitors
  - Reduced load capacitance

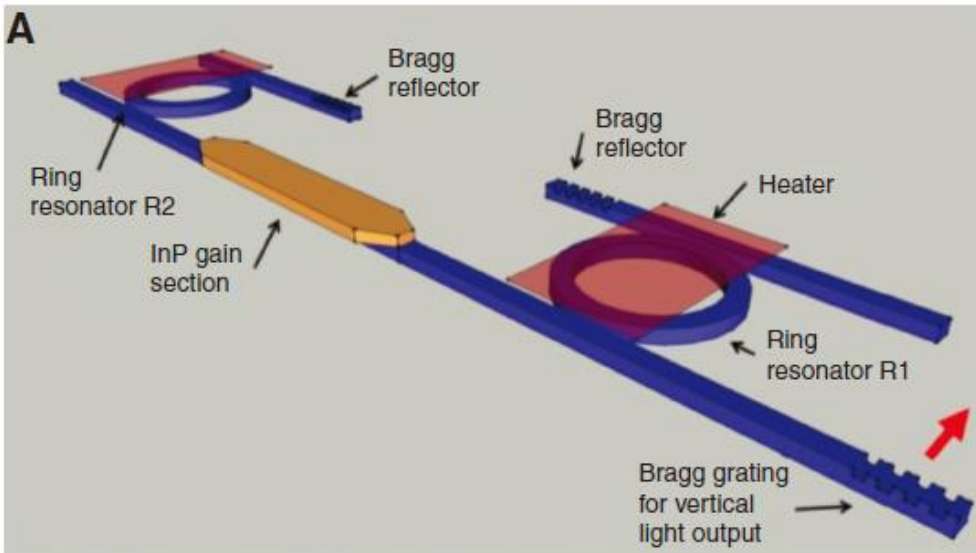
# Hybrid silicon/III-V lasers

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- ❑ On-chip laser source is important block on PICs.
- ❑ Adhesive and molecular wafer bonding techniques
- ❑ Reported by Dong et al. from Bell Labs

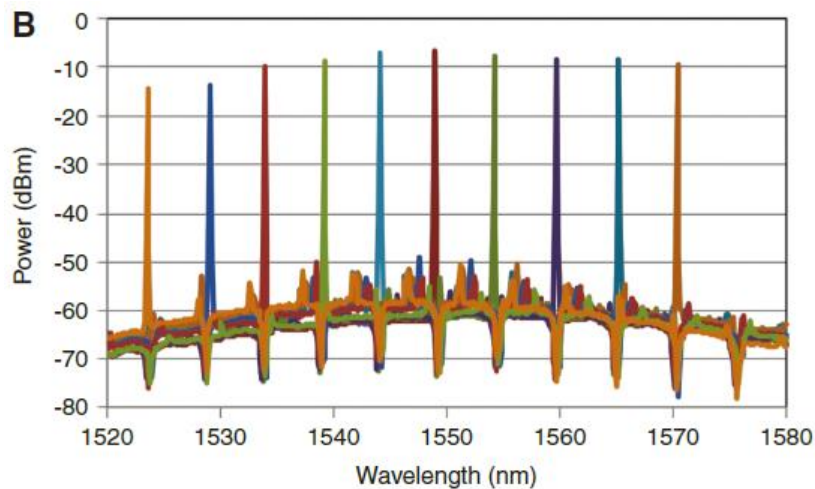
# Hybrid silicon/III-V lasers



- Wavelength tunable laser
  - InP-based amplification
  - Tapers
    - the modal transfer between III-V and Si
  - two ring resonators
    - single mode selection
  - Metal heaters
    - Thermal wavelength tuning
  - Bragg gratings
    - Reflection
    - Output fiber coupling

# Hybrid silicon/III-V lasers

- laser emission spectra
- Ring1: transmission dips
- Ring2: transmission peaks



- Combined power: <400mW
- side mode suppression: >40dB

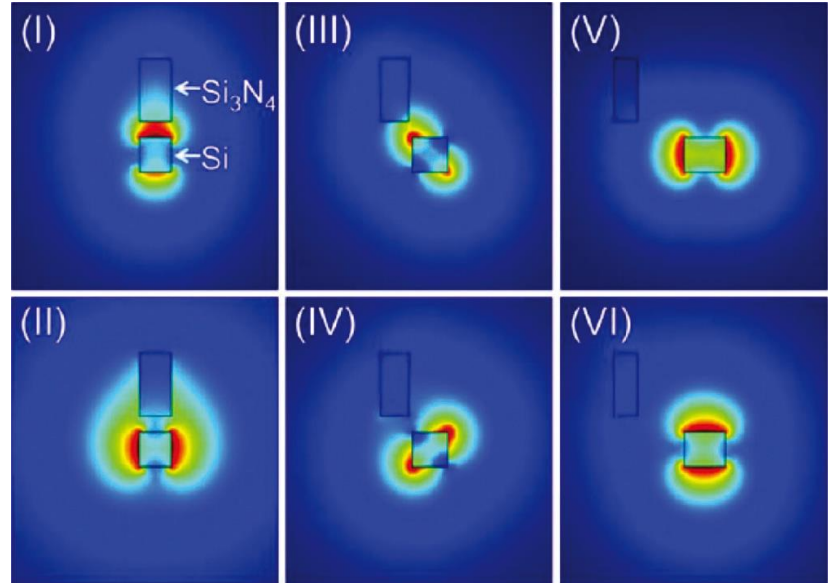
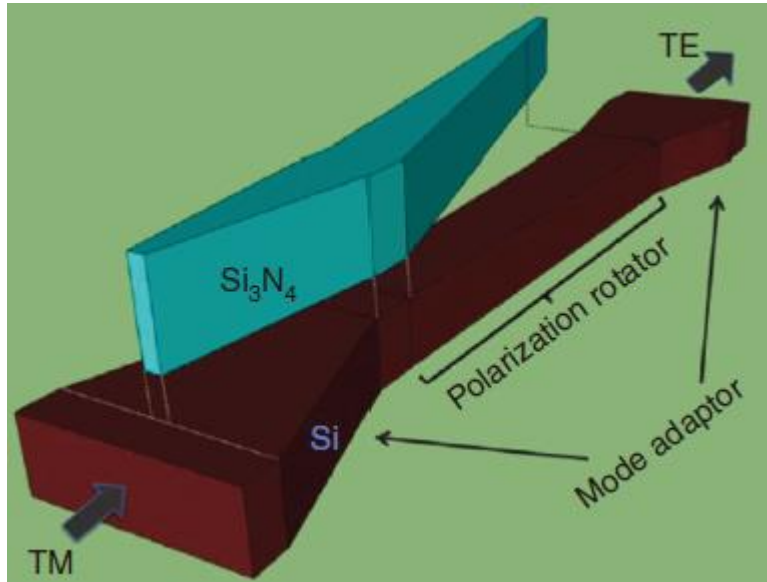


# On-chip polarization elements

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- Sub-um Si waveguides characteristics
  - different mode fields for TE and TM modes
  - effective indexes for TE and TM modes
  
- Solution: Polarization-diversified circuits
  - on-chip polarization elements are required
    - polarization rotators
    - polarization beam combiners/splitters

# SiN-assisted polarization rotators



- Adiabatic mode evolution
- >95% coupling efficiency for TM mode
- < 5% coupling efficiency for TE mode

# Conclusions

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## □ Applications

- Long-haul/metro coherent optical networks
- Optical interconnects for routers and switches
- Datacenters and supercomputers

## □ Devices

- On-chip Modulators – Single-drive push-pull Si MZMs
- On-chip Lasers – Si/III-V lasers
- On-chip Polarization elements - SiN-assisted polarization rotators