

Heating of Silicon Photonic Modulator



Article Overview

Silicon photonic modulators use integrated resistive heaters to thermally tune the resonant wavelength, with heater efficiency and reliability strongly influenced by material choice, thermal isolation, and electromigration considerations.

Thermal Tuning in Silicon Photonics

Silicon photonic modulators, particularly ring modulators, are highly sensitive to temperature due to silicon's large thermo-optic coefficient ($\sim 1.8 \times 10^{-4}$ 1/K), which can shift the resonant wavelength by up to 70 pm/K. Even small temperature variations (~ 0.1 K) can degrade optical link performance, making precise thermal control essential. To achieve this, metal heaters are integrated close to the silicon waveguide, allowing Joule heating to adjust the local temperature and tune the resonance.

Heater Architectures

Several heater designs are used in silicon photonics:

- Tungsten (W) heaters: Offer compact footprint and high resistivity, suitable for low-voltage CMOS driving. They are often placed above the waveguide and connected via Cu interconnects.
- Doped silicon and silicide heaters: Provide alternative resistive heating with different electrical resistivities, allowing flexibility in heater dimensions and power requirements.
- Thermal isolation structures: Trenches and substrate undercuts (UCUT) are used to...

Article Content

Electromigration Performance Improvement of Metal Heaters for Si ...

Abstract—Ring-based, resonant Si photonic (SiPho) devices are temperature sensitive and require thermal tuning for stable

Thermal modelling of Silicon Photonic Ring Modulator with Substrate ...

Si heater or even a doped Si waveguide have been studied in literature . The efficiency of the different heater topologies is very

Electro-Opto-Thermal Dynamic Compact Model for Ring Modulator

Silicon photonic (SiPho) ring modulators (RMs) are widely used in optical transceivers due to their excellent electro-optic (EO)

Thermal Modelling of Silicon Photonic Ring Modulator with Substrate ...

Ring modulators for silicon photonic (SiPho) optical transceivers are extremely thermally sensitive and require thermal tuning for

Comparison of heater architectures for thermal control of silicon ...

We will discuss and compare the different types of heaters (silicon, silicide and metal) in thermo-optic and electrical performance and

Integrated CMOS compatible low power 10Gbps silicon photonic

However, low power silicon photonics relies on resonators that are very sensitive to local temperature swings and heating must be

The Significance of Silicon Photonics Modulators in Optical ...

The incorporation of silicon-on-insulator offers stronger optical confinement in optical modulators. The first plasma dispersion silicon

Thermal annealing in silicon photonics ring modulators

Abstract: Silicon photonics technology promises significant improvements for fibre optic links of future upgrades of HEP experiments.

Highly uniform thermally undercut silicon photonic devices in a 300

These results open new opportunities for large-scale integrated photonic circuits using thermo-optic devices, paving the way for

Thermo-optic phase shifters based on silicon-on-insulator platform ...

Abstract Silicon photonic platforms offer relevance to large markets in many applications, such as optical phased arrays, photonic

A schematic of the silicon photonic MRM with metal heater.

Download scientific diagram | A schematic of the silicon photonic MRM with metal heater. from publication: A high-speed micro-ring

Silicon photonic modulator circuit with response

Fig. 1: Schematic of the programmable modulator. The embedded high-speed modulator can be travelling wave pn modulator, SiGe

Emerging Modulator Technologies in Silicon Photonics

The evolution of high-speed optical modulators in silicon photonics is crucial for advancing optical communication networks amid

Topology optimization of time-transient heat conduction for thermo ...

In this context, silicon (Si) modulators are critical components in future nano-scale photonics devices . In particular,

Thermal Tuning of Silicon Photonics Ring Modulators

Design and characterization of transmitter circuits architectures using silicon ring resonator modulators for high bit rate

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