UNIVERSITY OF DELAWARE - TECHNOLOGY LICENSING OPPORTUNITY | UD 26-049

Metal-Free Doped Silicon Thermo-Optic Heaters for High-Density Photonics

This doped silicon architecture breaks the historical trade-off between optical loss and thermal efficiency in silicon nitride photonic circuits. By replacing restrictive metal elements with a self-isolating, close-proximity semiconductor heating network, it provides biopharma, computing, and communications developers with a low-power, high-density tuning platform that slashes thermal crosstalk and operational energy demands.

TECHNOLOGY OVERVIEW

Modern integrated photonics relies heavily on silicon nitride (SiN) waveguides due to their broad transparency window and low propagation losses, making the dynamic control of light essential for signal routing and phase modulation. Thermo-optic phase shifters traditionally achieve this control by applying localized heat to alter the waveguide's refractive index; however, conventional metallic heating elements suffer from severe performance trade-offs. Placing metal heaters close to the waveguide to maximize thermal transfer introduces optical absorption losses that degrade signal integrity. Conversely, moving the metal farther away lowers thermal coupling efficiency, requiring unsustainable electrical power to achieve a phase shift, while a lack of thermal isolation allows heat to dissipate into the substrate, inflating power consumption and causing destructive thermal crosstalk.

University of Delaware Researchers have developed an advanced thermo-optic heater architecture that fundamentally resolves these performance trade-offs by introducing a completely metal-free heating solution optimized for SiN photonic waveguides. The platform utilizes electrically driven doped silicon as a resistive heating element placed in ultra-close proximity to the waveguide, eliminating metallic optical absorption while maximizing thermal transfer. A defining feature of this technology is the incorporation of engineered, thermally isolating undercut structures beneath the active area. These structural undercuts act as an advanced thermal barrier that confines heat strictly within the active device footprint, preventing unwanted dissipation into the surrounding substrate. By combining close-proximity silicon heating with precise thermal isolation, this architecture drastically enhances thermal coupling and enables highly efficient, localized, and low-power thermo-optic phase shifting across dense photonic circuits.

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KEY BENEFITS

Zero Metallic Optical Loss: Replaces traditional metal components with doped silicon, allowing ultra-close heater placement without inducing signal-degrading optical absorption.

Superior Thermal Isolation: Utilizes engineered undercut structures to trap and confine heat strictly within the active device zone, blocking wasteful dissipation into the chip substrate.

Low-Power Phase Shifting: Maximizes local thermal coupling to deliver highly efficient thermo-optic tuning at a fraction of the electrical power required by conventional heaters.

Flexible Layout Design: Supports multiple strategic heater configurations, allowing optical designers to optimize thermal distribution based on specific architecture limits.

WHAT WE ARE SEEKING : Licensing opportunities • Strategic partnerships • Industry feedback

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