Low-loss configuration solution for passive optical devices in Thailand

Article Overview

Optimizing passive optical devices for low-loss performance involves advanced waveguide design, precise alignment techniques, and material selection, with demonstrated propagation losses below 1 dB/cm in silicon photonics and sub-3 dB coupling loss using V-groove alignment.

Key Strategies for Low-Loss Passive Devices

1. Advanced Waveguide Design and Fabrication Using high-quality silicon-on-insulator (SOI) wafers with precise lithography and etching processes can achieve ultra-low propagation losses. For example, single-mode wire waveguides with dimensions of 400 nm x 220 nm have demonstrated propagation losses as low as 0.45 +- 0.12 dB/cm, while slot waveguides show around 2 dB/cm loss. Maintaining tight control over sidewall roughness and cross-sectional uniformity is critical for minimizing scattering and phase errors across the wafer, which is essential for wavelength-division multiplexing (WDM) applications in data centers and high-performance computing systems . 2. Passive Alignment Techniques Optimized passive V-groove alignment significantly improves fiber-to-chip coupling efficiency. By carefully controlling UV glue dispensing, lid bonding, and end separation, air bubble formation is minimized, reducing coupling loss from 11.46 dB to 2.68 dB. Incorporating index-matching materials further enhances light collection efficiency, providing a cost-effective solution for high-performance co-packaged optical systems . 3. Material Selection and Integration Silicon nitride and silicon waveguides are widely used for low-loss passive components due to their high optical quality and CMOS compatibility. For mid-infrared applications, InP-based platforms or hybrid integration with germanium waveguides can balance optical loss and thermal management. Monolithic integration on InP substrates is particularly advantageous for complex photonic circuits, enabling high-yield fabrication of passive components alongside active devices like lasers and modulators . 4. Passive Optical Isolation Integrated passive nonlinear optical isolators using silicon nitride ring resonators can provide non-reciprocal transmission with insertion losses as low as 1.3-5 dB while achieving isolation ratios up to 35 dB. These devices are fully passive, require no external power, and can be cascaded on-chip, making them suitable for stabilizing lasers and reducing back-reflection in integrated photonic systems .

Practical Considerations for Thailand

o Local Fabrication: Thailand has emerging photonics research centers and semiconductor foundries capable of producing SOI wafers and silicon photonic devices. Collaborating with regional foundries or universities can facilitate access to advanced fabrication processes.
o Integration with Data Centers: Low-loss passive devices are critical for high-bandwidth optical interconnects in AI, cloud computing, and 5G/6G networks. Implementing V-groove alignment and high-uniformity waveguides ensures minimal signal degradation.
o Material and Wavelength Choice: For telecom and near-infrared applications, silicon and silicon nitride are

preferred. For mid-infrared sensing, InP or hybrid Ge platforms are recommended to reduce optical losses and improve thermal performance.

Conclusion

Achieving low-loss passive optical devices in Thailand involves a combination of precision waveguide fabrication, optimized passive alignment, careful material selection, and integration of passive isolators. By adopting these strategies, propagation and coupling losses can be minimized, enabling high-performance photonic integrated circuits suitable for data centers, optical communication, and sensing applications .

A new strategy for low-loss optical devices when using high-loss materials. Using the decoupled phenomenon in the

They route, integrate, and interfere with optical signals, forming the basis for all of the functionalities required for managing

This paper aims to study the design, simulation, and optimization of low-loss Y-branch passive optical splitters up to

A high-capacity lithium-niobate-on-insulator (LNOI) optical transmitter for next-generation

We survey the state of the art in fundamental building blocks, including strip, rib, and silicon nitride waveguides, with a

This study evaluates the performance of three low-income passive housing designs at providing thermal comfort for

However, to achieve high-performance and CW lasing operation, efficient optical coupling between active and passive waveguide

In the very last years, optical access networks are growing very rapidly, from both the network operators and the

Conventional photonic packaging methods relying on edge or grating coupling are constrained by high insertion

Photonic Integrated Circuits (PICs) are taking a major role in the telecommunications and datacenter markets. The

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An FTTH network is a cost-effective and profitable solution based on passive technology. Compared to copper wires,

Optical Splitters Optical splitters are based on planar light wave circuit technology and high precision alignment. MXN splitters can

Using an advanced 300mm CMOS-platform, we report record-low and highly-uniform propagation loss: 0.45±0.12dB/cm for wires,

We demonstrate low-loss SiN passive optical components, encompassing straight and bend waveguides, 1 × 2MMI, 2 × 2MMI,

Next generation passive optical networks (NGPONs) are progressing towards future generation optical access

This paper provides a comprehensive review of recent progress in the foundational passive devices that underpin this

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